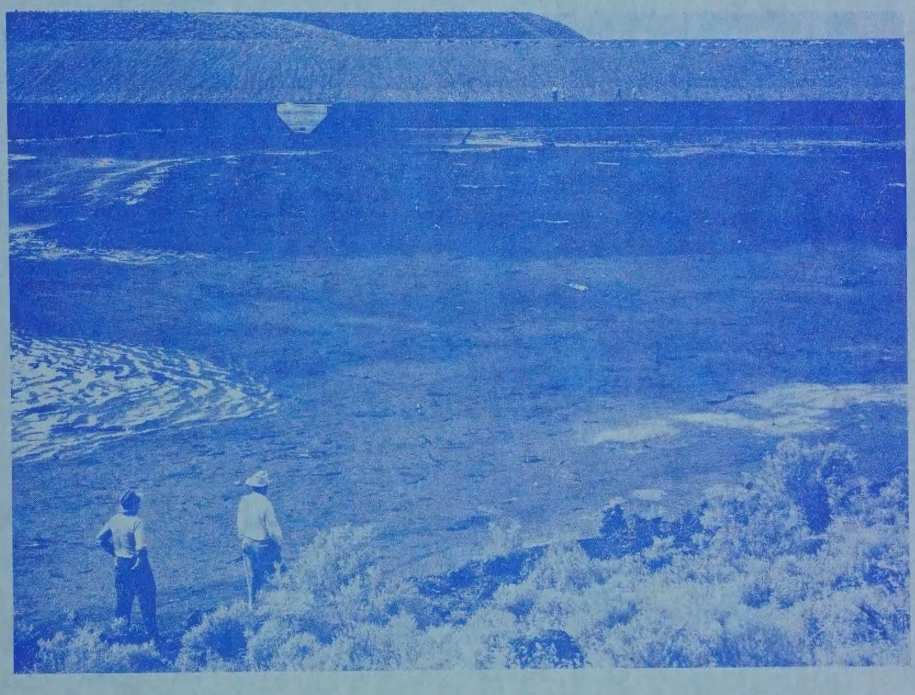
WATERSHED INVESTIGATION REPORTS
SEVIER RIVER BASIN, UTAH



Appendix IV

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service

May 1973

WATERSHED INVESTIGATION REPORTS

SEVIER RIVER BASIN, UTAH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service

May 1973

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I N T R O D U C T I O N

This supplement to the Sevier River Basin Report describes those watersheds with potential and need for development through the Watershed Protection and Flood Prevention Act (Public Law 566) within the next 10 to 15 years. Results of investigations presented here are limited to those developments which have a favorable benefit-cost ratio. Portions of projects not found feasible are not described. Information regarding these is available in Soil Conservation Service files.

Additional studies indicated seven other projects would be feasible for construction beyond the next 10 to 15-year period. Also, changing needs and economic factors will change the timing for development in many of the study areas.

The Basin-wide coordinated plan of development outlined in the Early Action Program report should be initiated. This plan would include the projects outlined here along with many other developments needed that do not qualify under PL-566. Refer to the Early Action Program report for a detailed description of the coordinated plan of development. In addition, the appendices published with the Sevier River Basin report also provides useful information concerning the development of these watersheds.

Most of the projects are oriented toward agricultural water management. The composite costs for project structural measures show a ratio of agricultural water management to flood protection features of 3.4:1. This may change in the final planning stages.

Some of the terminology used in this report is defined below in order to facilitate a better understanding of the total concept.

ROOT-ZONE WATER: Water delivered and available to the plant root zone used for production of plant fiber or discharged to the atmosphere.

ROOT-ZONE WATER DEFICITS: The difference between root-zone water required to satisfy potential consumptive use and that amount actually available. For project benefit evaluation purposes, the root-zone water deficits have been computed by frequency analysis. These values will differ from the average annual quantities shown in the average annual water budget analysis.

DISTRIBUTION EFFICIENCY: The transportation efficiency of the main distribution system which delivers water to the farm headgate.

ON-FARM EFFICIENCY: The efficiency of the irrigation method used to deliver water from the farm headgate to the root zone.

DOWNSTREAM EFFECTS: In some projects where agricultural water management features increase or decrease consumptive use on irrigated lands, the average annual outflow from the watershed may increase or decrease and effect the supply to downstream irrigated lands.

Generally, unfavorable downstream effects are compensated for by decreasing consumptive use by phreatophytes and by regulation of the groundwater reservoirs to maintain outflow volumes. Detailed evaluation of these compensating effects on individual watersheds were not analyzed at this level of investigation. The reader is referred to the Main Report and Early Action Program report for a discussion of this on a Basin-wide basis.

The following actions describe the project features of the twelve potential projects found feasible for construction during the next 10 to 15-year period. The Project Opportunity Map following page 3 shows the location of these watersheds. The following table presents a summary of the project cost and benefit estimates for these twelve watersheds.

NORTH SANPETE WATERSHED (A-1)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
SANPETE COUNTY, UTAH
March 1968

T H E W A T E R S H E D I N B R I E F

This watershed is located in Sanpete County, Utah, and contains 210,500 acres. Its area is approximately 4 percent of the Sevier River Basin. Total watershed acres are grouped as follows: Private land, 128,640 acres; state lands, 21,120 acres; public domain, 1,840 acres; and Manti-LaSal National Forest lands, 58,900 acres. The principal town is Mount Pleasant, with a population of 1,577 (1960 census). Other small communities include Moroni, Fairview and Spring City with 1960 census populations of 879, 655, and 463, respectively. The total watershed population was estimated to be 4,017.

PREVIOUS PLANS AND PROJECTS

Pleasant Creek Pilot Watershed Project - This project included the area drained by Pleasant Creek which experiences frequent flooding from high intensity thunderstorms. The project included land treatment measures on the upper watershed for soil stabilization and floodwater reduction. Debris basins were constructed to remove sediment suspended from floodwaters and provide flood routing capacity to reduce the size of flood peaks. Channel improvement through town and irrigation water control structures were included. The benefits of the project are to the town of Mount Pleasant and surrounding irrigated lands.

North Sanpete Watershed Plan - The North Sanpete Watershed Work Plan was completed in September of 1961. This plan includes a proposed reservoir (Narrows Reservoir) on Gooseberry Creek tributary to Price River above lower Gooseberry Reservoir. From this reservoir, it was planned to divert stored water through a tunnel into Cottonwood Creek. Water right litigation has halted project installation since 1961. A coordinated water development plan can provide a basis for Carbon and Sanpete County water users to reach an agreement on rights to store water at a site along Gooseberry Creek and divert this water into Sanpete County. Without a right to store water, the previous PL-566 Work Plan must be revised. A new project could include agricultural water management measures, flood protection, and recreation.

CONCURRENT PLANNING WITH OTHER PROJECTS

Groundwater reserves provide a potential water supply needed to meet irrigated crop needs. The full development of groundwater reserves is limited by downstream return flow water rights. Concurrent planning of this watershed and Watersheds A-2, A-3, and A-4 is recommended as a solution to make the best use of surface and groundwater supplies. Concurrent planning would enable exchange of surface water supplies and groundwater supplies. Additional investigations are needed to determine physical and economic feasibility.

MAP 14
PROJECT OPPORTUNITY MAP
(PL-566)
NORTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

SCALE IN MILES 0 1 2 3 4 5 6 7 8 9

LEGEND

- Project completed
- Project under construction
- Project feasible, next 10-15 years
- Project feasible, next 10-15 years as supplement to completed project
- Future project feasible
- Project not feasible
- Potential water salvage areas
- C5-6 Reservoir or debris basin site and index number
- Channel improvement area

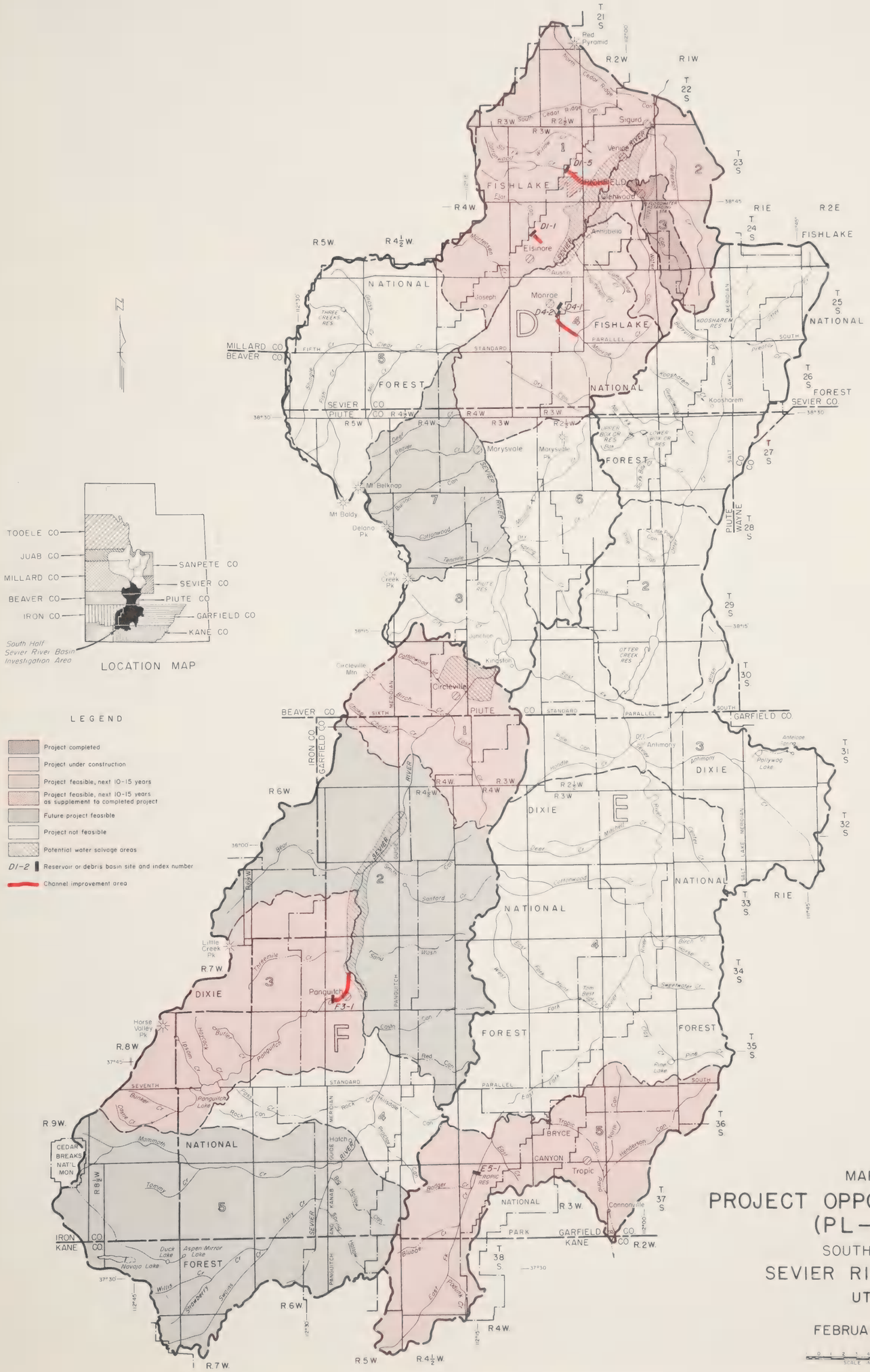
LOCATION MAP

TOOELE CO. · JUAB CO. · MILLARD CO. · BEAVER CO. · IRON CO. · SANPETE CO. · SEVIER CO. · PIUTE CO. · GARFIELD CO. · KANE CO.

North Half Sevier River Basin Investigation Area

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1969

NORTH HALF M7-S-18914-N



MAP 14

PROJECT OPPORTUNITY MAP (PL-566)

SOUTH HALF SEVIER RIVER BASIN UTAH

FEBRUARY 1969

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

SOUTH HALF M7-S-18914-N

FOUNTAIN GREEN WATERSHED (A-2)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
SANPETE AND JUAB COUNTIES, UTAH
March 1968

THE WATERSHED IN BRIEF

This watershed is located in Sanpete and Juab Counties, Utah, and contains 103,200 acres and is 2 percent of the Sevier River Basin area (Figure 1). The principal towns are Fountain Green and Wales with populations of 544 and 130, respectively. The 1960 total watershed population was 847. There are private lands, 64,040 acres; state lands, 10,560 acres; Federal lands administered by the Bureau of Land Management, 18,079 acres; and Uinta National Forest lands, 10,521 acres.

There are 7,900 acres of rotated irrigated cropland which is 70 percent alfalfa hay, 20 percent small grain, 3 percent corn silage, and 7 percent idle. Wet meadows comprise 10,120 acres and phreatophytes, 1,920 acres.

The average annual precipitation for the watershed ranges from 25 inches in the higher elevations to 10 inches in the valley. The irrigated cropland receives an average of 11.5 inches annually. Elevations range from 5,400 to over 9,700 feet.

The irrigation water supply is obtained from the San Pitch River, Big Spring, Wales Reservoir, which stores groundwater return flows from the Fountain Green area, and a number of smaller springs and drainages from Gunnison Plateau and Cedar Hills. Total water yield of the watershed averages 18,500 acre-feet annually.

Approximately 90 percent of the soils in the watershed are Upland range sites and Argixerolls. Wetlands comprise approximately 10 percent of the watershed. The remainder consists of Mountain and High Mountain range sites, Cryoborolls and Cryoboralfs, Semidesert range sites, Haplargids, and Wetlands. The vegetation is varied with portions of aspen, conifer, pinyon-juniper, oakbrush, sagebrush and greasewood.

The area is composed of three basic geologic structures which have an influence on the water resources. The most outstanding and influential feature, although somewhat dwarfed by nearby Mt. Nebo and the Southern Wasatch Mountain, is the Gunnison Plateau where elevations range to nearly 10,000 feet, over 4,000 feet above the valley floor. The plateau is a broad synclinal block of Mesozoic and Tertiary rocks dipping 5° to 30° to the east and whose eastern limb is sharply

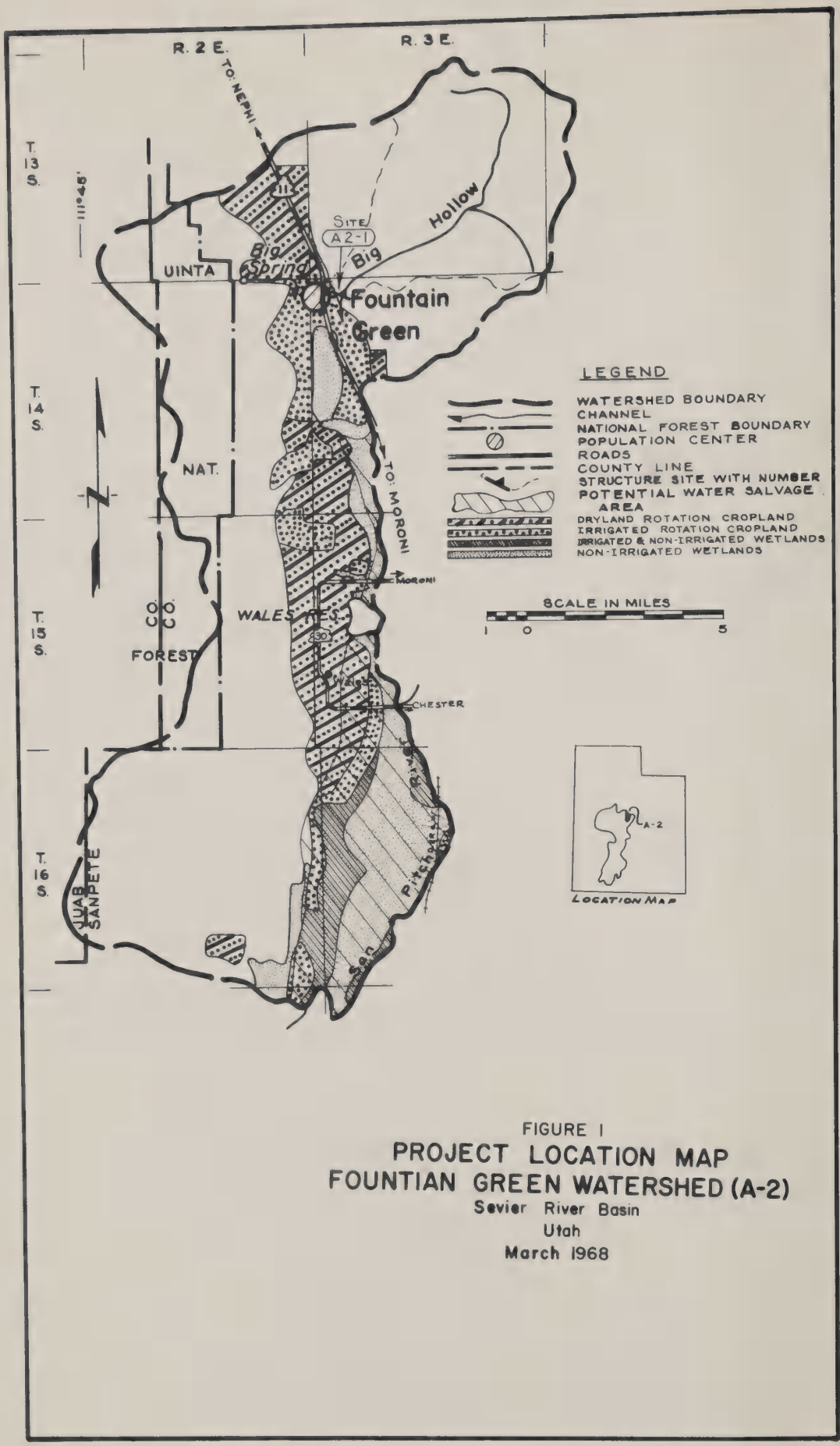


FIGURE 1

PROJECT LOCATION MAP
FOUNTIAN GREEN WATERSHED (A-2)

Sevier River Basin
Utah
March 1968

overturned. This, coupled with the lower Cretaceous sediments in the plateau, provide the means of supplementing the water supply on the eastern slopes with that from the west. This transmountain groundwater flow is estimated at 6,720 acre-feet annually.

A relatively narrow valley underlain by Cretaceous and Tertiary rocks was formed by the Gunnison fault and separates the Cedar Hills from the Gunnison Plateau.

The Cedar Hills are mostly Jurassic, Cretaceous, and Tertiary rocks, folded in most of the area and broken by faulting, principally in the southern portion. They are a relatively unimportant water source area.

W A T E R S H E D P R O B L E M S A N D N E E D S

LAND TREATMENT NEEDS

Land treatment on upper lands is needed to correct unsatisfactory watershed conditions resulting from excessive erosion and unstable soils. This will help reduce sediment yields and lower flood peaks.

Land treatment needs for irrigated lands are orientated around water management. These needs are related to sediment deposits and conveyance problems.

FLOOD PREVENTION AND SEDIMENT CONTROL

All of the drainages have recorded flood and sediment damages. The Big Hollow drainage has produced flood and sediment damages that average $1,900 annually. Flood channels in the valley areas are flat and must be cleaned periodically to prevent additional flood damage to agricultural areas. Historically, several floods have damaged the community of Wales. Flooding occurs on a seasonal basis with the most damaging storms occurring during July and August. These are generally convective storms which damage irrigation systems and interrupt irrigation operations. Sediment deposition damages both irrigated and dryland farms.

AGRICULTURAL WATER MANAGEMENT

Annual irrigation water crop requirements are 20,400 acre-feet. The average annual water supply is 15,300 acre-feet leaving a deficit of 5,100 acre-feet. This varies from 2,000 acre-feet 8 out of 10 years to 8,000 acre-feet 2 out of 10 years. The deficit results from a combination of conditions: Low irrigation efficiencies, inadequate regulatory storage facilities, improper water management, and a short water supply. The systems are now operating at an average overall efficiency of 31 percent. Irrigation water distribution is hampered by excessive canal seepage, inadequate regulatory devices, and farm field topography. Land leveling, on-farm headgates, ditch lining, and adequate regulatory turnouts from the main canals are needed to help reduce water deficits.

WETLANDS

There are 12,040 acres that have high water tables. Lowering the water table will permit a change in land use from a wet meadow to rotated crops and improved pasture.

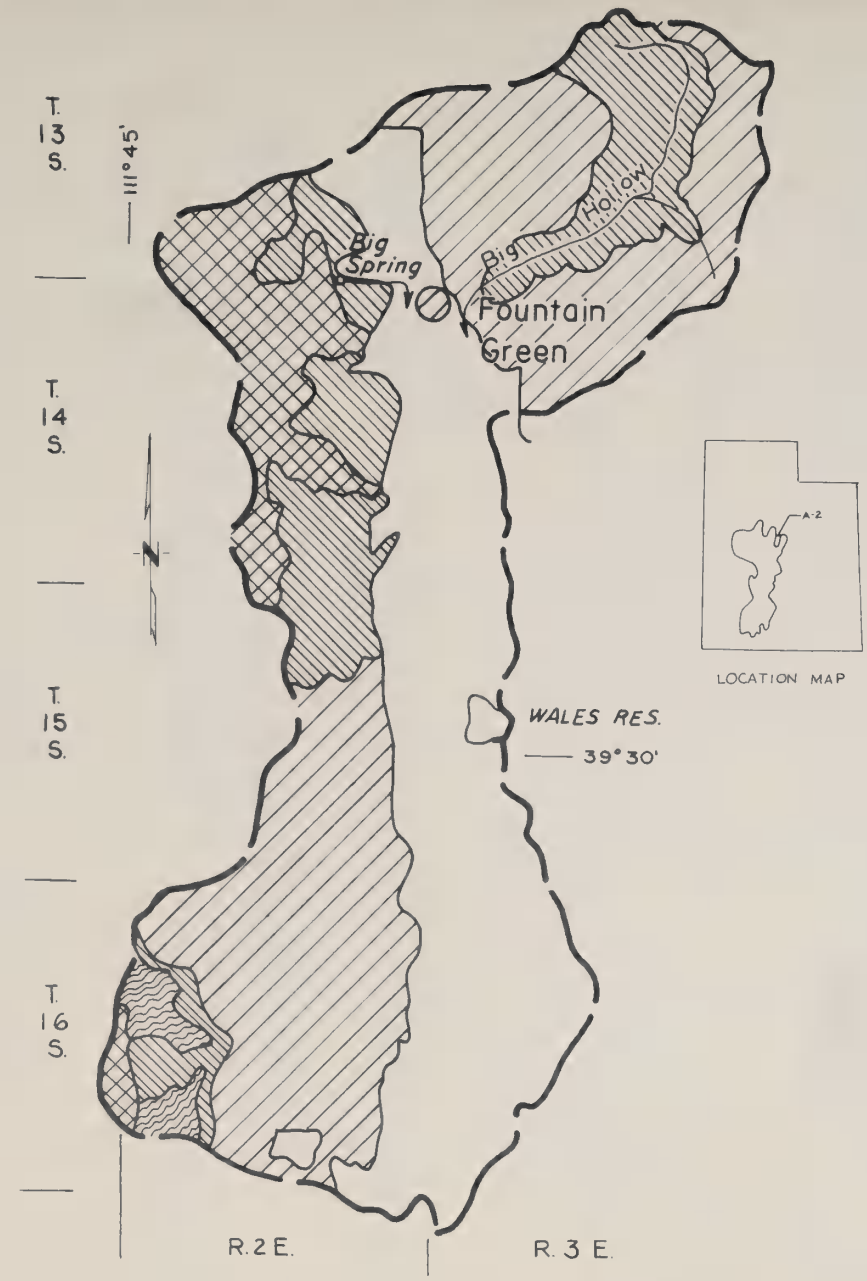
EROSION CONDITION

There are approximately 10,000 acres with heavy to excessive erosion, 25,000 acres with light to moderate erosion, and 42,000 acres in the incipient stage of erosion. An additional 25,000 acres are unclassified (Figure 2, Erosion Condition Map).

P H Y S I C A L P O T E N T I A L F O R M E E T I N G N E E D S

Site A2-1 on Big Hollow drainage can provide storage for flood and sediment, recreation, and water supply (Figure 1, Location Map). The average annual water yield from Big Hollow is 1,060 acre-feet. In addition, a pipeline from Big Spring to the reservoir would provide additional winter water for storage.

The wetland areas have potential for conversion to a more efficient water and land use by lowering the water table. Total consumptive use is now 33,000 acre-feet annually. The watershed yield



LEGEND

- Incipient Erosion
- Light to Moderate Erosion
- Heavy to Excessive Erosion
- Geological Erosion
- Unclassified

SCALE IN MILES

1 0 1 2 3 4

FIGURE 2

EROSION CONDITION MAP
FOUNTAIN GREEN WATERSHED (A-2)

Sevier River Basin
Utah
March 1968

contributes approximately one-third of the consumptive use; the remainder is supplied from groundwater common to and replenished from adjacent watersheds. Potential water salvage of 24,750 acre-feet from these wetlands can provide additional water for use elsewhere. This is a major potential for developing additional irrigation water.

The eradication of phreatophytes and conversion of wetlands to pasture and rotated croplands may have a detrimental effect on waterfowl and fish habitat.

LOCAL INTEREST IN PROJECT DEVELOPMENT

The Sanpete County Soil Conservation District is providing leadership in water development within this watershed. Irrigation companies are supporting planning and project measures to better utilize soil and water resources. Local sponsors have filed for the possible planning assistance under PL-566 for 2,230 acres in the Tidds Canyon area. An amendment to this application could include the balance of this watershed.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT

Land treatment measures for the upper watershed areas applicable for acceleration under a project are as follows: Chaining, contour trenching and seeding, and grass reseeding.

Irrigated lands need leveling in order to achieve potential and to cope with buildup of sediment which causes excessive operation, repairs and maintenance costs. Ditch lining, sprinkling, and other water management practices are also applicable to the irrigated farm lands.

STRUCTURAL MEASURES

Site A2-1, Big Hollow, with a total capacity of 2,300 acre-feet is included for development. It will include storage for flood detention, recreation, and irrigation water.

Agricultural water management measures will include canal lining, pipelines, and wells. The canal lining will be done on the distribution systems of Fountain Green and Wales Reservoir-Silver Creek Irrigation Companies. The canal capacities will vary from 10 c.f.s. to 20 c.f.s. Pipelines for Peach Canyon, Reese Spring and Current Creek will include 3 miles of pipe ranging in size from 6 inches to 10 inches in diameter. One mile of pipeline will be installed between Big Spring and Site A2-1, Big Hollow. It will serve a dual purpose as irrigation outlet works and inlet pipe for water from Big Spring. Fifty irrigation wells producing flows of about 1.75 c.f.s. each are planned to provide 15,750 acre-feet per year.

N A T U R E A N D E S T I M A T E O F C O S T S O F I M P R O V E M E N T S

STRUCTURAL DEVELOPMENTS CONSTRUCTION

Construction costs for normal conditions were applied for all structural development. A 25-percent contingency factor was applied to estimated reservoir construction costs. Sizes and quantities were determined by low intensity investigations. (Table 1, 2, and 3)

ENGINEERING SERVICES

Engineering services costs were estimated as 12 percent of the construction costs.

EASEMENTS AND RIGHTS-OF-WAY

Included in this item is a minimal amount reflecting legal and near negligible easement costs. Most of the developments are either on Federal lands or on rights-of-way held by irrigation companies.

TABLE 1.--Structure data - storage capacity, Fountain Green Watershed (A-2), Sevier River Basin

Item	Unit	Value or material
Site number and name		A2-1, Big Hollow
Drainage area	Square miles	22.73
Estimated volume of fill	Cubic yards	566,500
Principal spillway		
Type		R/C Conduit
Release rate	CSM	13
Emergency spillway		
Type		Conc.
Chance of use	Percent	1
Maximum surface area		
Emergency spillway level	Acres	65
Recreation pool	Acres	40
Storage capacity		
Sediment	Acre-feet	405 (.3)[a]
Floodwater	Acre-feet	370 (.3)[a]
Flood prevention total	Acre-feet	775 (.6)[a]
Recreation	Acre-feet	370
Water supply	Acre-feet	1,055[b]
Grand total	Acre-feet	2,200

[a]Inches equivalent.

[b]The Detention Pool will be used for regulatory storage for winter months prior to June.

TABLE 2.--Estimated structural cost-potential development,[a] Fountain Green Watershed (A-2), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Canal lining	Miles	21	287,500
Pipelines	Miles	3	33,200
Wells	Each	50	537,500
Multipurpose structures & developments	Each	1	800,500
Total			1,658,700
Engineering services			199,080
Land easements & rights-of-way			2,200
Grand total			1,859,980

[a]Price Base 1967.

TABLE 3.--Distribution of structural cost-potential development,[a] Fountain Green Watershed (A-2), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Canal lining				
Fountain Green Irrigation Co.	262,500	31,500	500	294,500
Wales Reservoir - Silver Creek Irrigation Co.	25,000	3,000	200	28,200
Pipelines				
Peach Canyon	13,700	1,640	50	15,390
Reese Spring	8,500	1,020	50	9,570
Current Creek	11,000	1,320	50	12,370
Wells	537,500	64,500	1,000	603,000
Reservoir and developments				
Site A2-1, Big Hollow	708,000	85,000	200	793,200
Big Spring pipeline	47,500	5,700	50	53,250
Distribution canal	15,000	1,800	50	16,850
Campgrounds	30,000	3,600	50	33,650

[a]Price Base 1967.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs were based on the expected life and repair costs for each item. An additional $5.00 per acre-foot of planned pumping was added as power cost when deriving well replacement, operation, and maintenance costs. (Table 4)

COST ALLOCATION

The use of facilities method was used to allocate costs of the multiple-purpose structures. (Table 5)

PROJECT ADMINISTRATION

This cost was estimated as 13 percent of the construction costs.

E F F E C T S A N D E C O N O M I C F E A S I B I L I T Y O F P O T E N T I A L D E V E L O P M E N T

Site A2-1, Big Hollow Reservoir, will provide flood protection for the 100-year frequency occurrence. Floodwater and sediment damage reduction benefits are $1,940 per year. On-site recreation with fishing benefits on the 41 surface-acre reservoir are $1,850 per year. Campground benefits for 30 family units and two group units are $6,000 per year. The remaining reservoir capacity (1,055 acre-feet) is planned for irrigation water storage to be used in partially satisfying the average annual deficit of 5,100 acre-feet. This would yield an annual direct benefit of $40,090, at $38.00 per acre-foot. (Table 6)

A pipeline to bring winter water from Big Spring is planned to supplement the natural surface inflow. This would eliminate much of the water lost during winter months. Estimated benefits for this system are $5,840. A distribution system is planned to deliver reservoir water to irrigation companies. This would reduce conveyance loss with an annual benefit of $1,950.

It is assumed that there would not be any change in land use in the flood plain so land enhancement benefits to agriculture were not evaluated.

TABLE 4.--Annual costs,[a] Fountain Green Watershed (A-2), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Irrigation distribution systems			
Canal lining			
Fountain Green Irrig. Co.	9,980	8,820	18,800
Wales Reservoir - Silver Creek Irrig. Co.	960	840	1,800
Pipelines			
Peach Canyon	520	460	980
Reese Spring	320	290	610
Current Creek	420	370	790
Wells	20,440	84,400[c]	104,840
Multipurpose reservoir and developments			
Site A2-1, Big Hollow	26,890	3,540	30,430
Big Spring pipeline	1,810	640	2,450
Distribution canal	570	500	1,070
Campgrounds	1,140	670	1,810
Project administration	---	---	7,300
Grand total	---	---	170,880

[a]Price Base 1967.

[b]100 yrs. @ 3¼ percent interest.

[c]Includes pumping costs.

TABLE 5.--Cost allocation and cost sharing summary,[a] Fountain Green Watershed, Sevier River Basin

Item	Cost allocation				Cost sharing							
	Purpose				Federal				Nonfederal			
	Flood Prevention	Recreation	A.W.M.	Total	Flood Prevention	Recreation	A.W.M.	Total	Flood Prevention	Recreation	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Canal lining												
Fountain Green Irrig. Co.	---	---	294,500	294,500	---	---	162,750	162,750	---	---	131,750	131,750
Wales Reservoir - Silver Creek Irrig. Co.	---	---	28,200	28,200	---	---	15,500	15,500	---	---	12,700	12,700
Pipelines												
Peach Canyon	---	---	15,340	15,340	---	---	8,490	8,490	---	---	6,850	6,850
Reese Spring	---	---	9,520	9,520	---	---	5,270	5,270	---	---	4,250	4,250
Current Creek	---	---	12,320	12,320	---	---	6,820	6,820	---	---	5,500	5,500
Wells	---	---	602,000	602,000	---	---	64,500	64,500	---	---	537,500	537,500
Reservoir & developments												
Site A2-1, Big Hollow	279,130	133,230	380,640	793,000	279,130	73,750	210,710	563,590	---	59,480	169,930	229,410
Big Spring pipeline	---	---	53,200	53,200	---	---	29,450	29,450	---	---	23,750	23,750
Distribution canal	---	---	16,800	16,800	---	---	9,300	9,300	---	---	7,500	7,500
Campgrounds	---	33,650	---	33,650	---	18,600	---	18,600	---	15,050	---	15,050
Grand total	279,130	166,880	1,412,520	1,858,530	279,130	92,350	512,790	884,270	---	74,530	899,730	974,260

[a]Price Base 1967.

TABLE 6.--Comparison of benefits and costs,[a] Fountain Green Watershed (A-2), Sevier River Basin

Evaluation units	Average annual benefits					Total benefits	Average annual cost[b]	Benefit cost ratio
	Flood damage reduction	Recreation		A.W.M.	Secondary			
		Fishery	Campground					
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	
Irrigation distribution systems								
Canal lining								
Fountain Green Irrig. Co.	---	---	---	12,300	2,460	14,760	18,800	0.8:1
Wales Reservoir - Silver Creek Irrig. Co.	---	---	---	2,810	560	3,370	1,800	1.9:1
Pipelines								
Peach Canyon	---	---	---	1,600	320	1,920	980	1.9:1
Reese Spring	---	---	---	530	110	640	610	1.0:1
Current Creek	---	---	---	1,790	360	2,150	790	2.7:1
Wells	---	---	---	115,520	23,100	138,620	104,840	1.3:1
Multipurpose reservoir								
A2-1, Big Hollow								
Reservoir	1,940	1,850	---	40,090	8,020	51,900	30,430	1.7:1
Big Spring pipeline	---	---	---	5,840	1,170	7,010	2,450	2.9:1
Distribution canal	---	---	---	1,950	380	2,330	1,070	2.2:1
Campgrounds	---	---	6,000	---	1,200	7,200	1,810	4.0:1
Land treatment residual	---	---	---	43,140	8,630	51,770	---	---
Project administration	---	---	---	---	---	---	7,300	---
Grand total	1,940	1,850	6,000	225,570	46,310	281,670	170,880	1.6:1

[a]Price Base 1967.

[b]From Table 4.

Canal lining for Fountain Green Irrigation Company would increase conveyance efficiencies and the root zone supply by 300 acre-feet. Benefits are $11,400 per year; an additional $900 benefit will accrue to the Canal company from reduced annual maintenance cost, making a total annual benefit of $12,300 per year. Canal lining for Wales Reservoir-Silver Creek Irrigation Company, would increase root zone water supply by 74 acre-feet for an annual benefit of $2,810.

Pipeline systems to convey reservoir and well water would increase efficiencies and root zone water supplies. Peach Canyon system improvements will increase conveyance efficiency from 70 percent to 90 percent and add 42 acre-feet root zone water with an annual benefit of $1,600. Reese Spring pipeline would increase conveyance efficiency from 70 percent to 90 percent and save approximately 14 acre-feet root zone water for estimated annual benefits of $530. Current Creek pipeline would increase conveyance efficiency from 70 percent to 90 percent and increase root zone water by 47 acre-feet. This would result in annual benefits of $1,790.

Residual benefits from on-farm land treatment practices are $43,140 per year from increased on-farm water-use efficiency, land leveling and improved irrigation facilities.

The 50 wells would supply approximately 3,040 acre-feet measured at the crop root zone for an annual benefit of $115,520.

Redevelopment benefits and national secondary benefits were not evaluated. Total annual benefits to agricultural water management are $225,570. Local secondary benefits were estimated to be 20 percent of the derived primary benefits and are $46,310 per year. The ratio of average annual benefits to average annual costs for all works of improvement, including primary and local secondary benefits are 1.6:1. The benefit-cost ratio excluding local secondary benefits is 1.3:1.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Coordinated planning with Watersheds A-1, A-3, and A-4 is necessary for additional water development. It will be necessary, with the level of development described, to analyze the total downstream effect with more extensive investigations.

EPHRAIM WATERSHED (A-3)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
SANPETE COUNTY, UTAH
March 1968

T H E W A T E R S H E D I N B R I E F

This watershed is located in Sanpete County, Utah, and contains 59,100 acres (Figure 3). It is a tributary to the San Pitch River and comprises 1.1 percent of the Sevier River Basin. A breakdown of land status is as follows: Private lands, 27,740 acres; state lands, 3,200 acres; Federal lands administered by the Bureau of Land Management, 1,410 acres; and Manti-LaSal National Forest lands, 26,750 acres. The town of Ephraim contains 1,800 of the total 1,819 population (1960 census). The 1940 to 1960 population trend was declining.

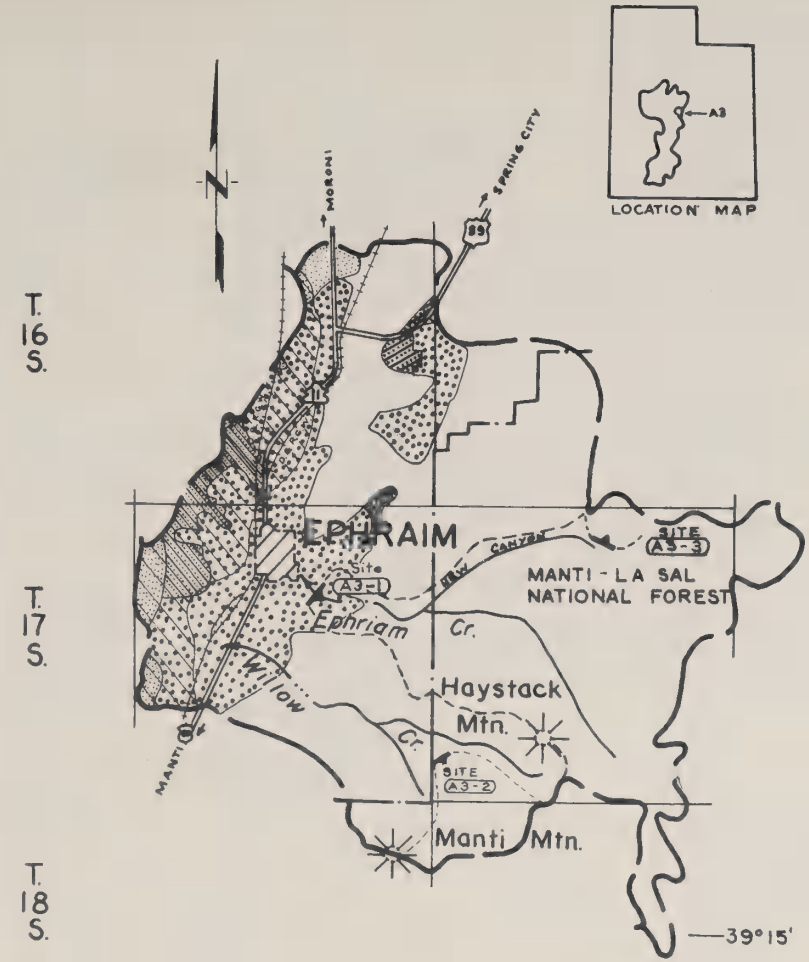
Irrigated rotation cropland comprises 10,000 acres of the watershed of which approximately 73 percent is alfalfa hay, 20 percent small grain, 2 percent corn silage, and 5 percent idle ground. Wet meadow and noncropped phreatophytes cover 4,000 acres.

The average annual precipitation for the watershed ranges from 10 inches in the lower elevations to 35 inches in the high elevations. Precipitation on irrigated rotation cropland averages 10.7 inches. The elevations vary from 5,500 feet to 11,100 feet.

The range sites and soils are: High-Mountain range sites and Cryoboroll and Cryoboralf soils, 35 percent; Mountain range sites and Cryoborolls and Upland range sites and Argixeroll, Calcixeroll and Haploxeroll soils, 45 percent; Semidesert range sites and Torrifluvent and Calciorthid soils, 15 percent; and Wetlands that are Haplaquepts, 5 percent. The vegetation cover is aspen, conifer, pinyon-juniper, sagebrush, oakbrush, and cultivated crops.

Geologically, the valley lands of Sanpete Valley are underlain by an anticline formed during the Larimide orogeny. This structure is covered by Quaternary alluvial deposits derived chiefly from the Wasatch Plateau moncline on the eastern flank of the watershed. This high plateau contributes most of the irrigation water to the land below.

The tributary outflow of the watershed amounts to 31,000 acre-feet annually. Irrigation water comes from three sources:



LEGEND

- Watershed Boundary
- Reservoir Site
- A3-1 Index Number
- National Forest Boundary
- Channel
- Township Boundary
- Center Populated Area
- Potential Water Salvage Area
- Irrigated Rotation Cropland
- Dry Land Rotation Cropland
- Irrigated & Non-Irrigated Wetlands
- Non-Irrigated Wetland

FIGURE 3

PROJECT LOCATION MAP EPHRAIM WATERSHED (A-3)

Sevier River Basin
Utah
March 1968

1 0 1 2 3 4

Scale in Miles

(1) The main source is the natural flow of the Willow Creek and Ephraim Creek drainages.

(2) Five transmountain diversions bring water into the area during the snow-melt runoff period. Four of these divert into Ephraim Creek. The other diverts into the Horseshoe Canal and Larsen Irrigation Company Canal.

(3) Approximately 17 percent of the present water supply comes from wells.

W A T E R S H E D P R O B L E M S A N D N E E D S

FLOOD PREVENTION AND SEDIMENT CONTROL

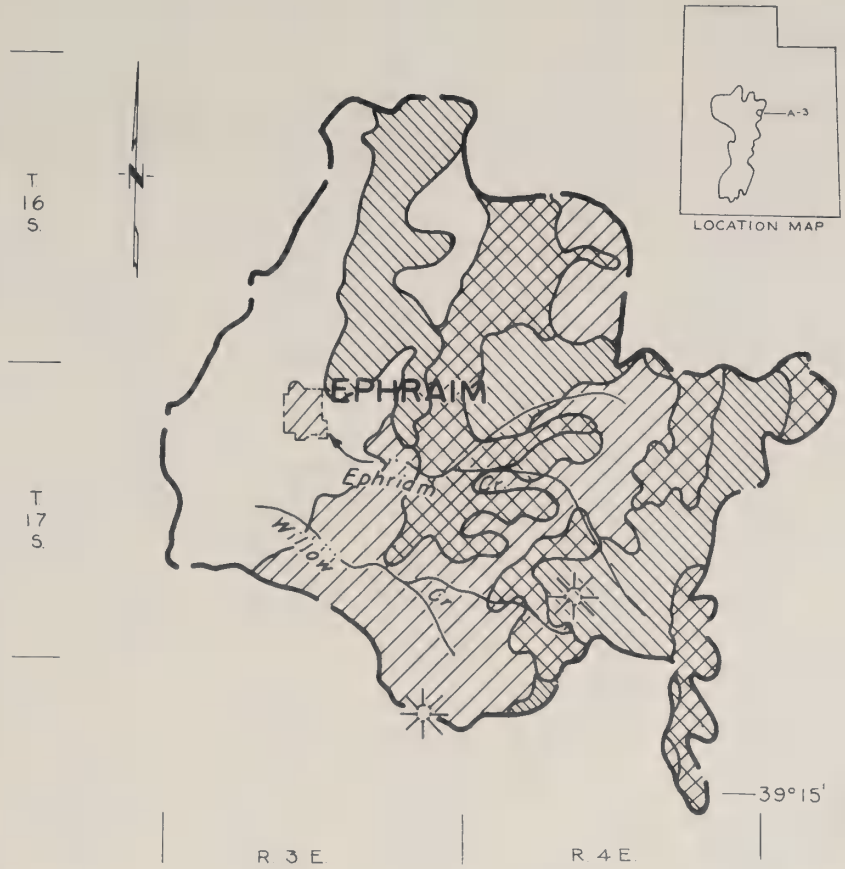
Flood damages from 1889 to 1936 totaled $131,030. From 1936 to the present, the flood damages have been minor.

Sediment damages to irrigation systems and irrigated croplands occur yearly during the snow-melt runoff period. The Ephraim Creek Irrigation Company distribution system incurs an annual damage of $1,000 from sediment deposition. Sediment damage at the mouth of Willow Creek is similar to that of Ephraim Creek. Ephraim Creek has a very high sediment yield estimated at 4.2 acre-feet per square mile.

EROSION

Erosion is a serious problem on areas where vegetation does not adequately protect the soil. This lessens the productivity and makes it increasingly difficult to restore a good vegetation-soil-water hydrologic relationship. Steep slopes and high intensity rainfall adds to the problem. Streambank erosion also contributes heavily to the sediment yield. Transmountain diversions are adding to this problem in some upstream areas.

The watershed has 1,770 acres with geologic, 13,000 acres heavy to excessive, 13,000 acres light to moderate, and 25,400 acres incipient stage of erosion (Figure 4). Control measures, especially land treatment, can reduce erosion on these lands.



LEGEND

- Incipient Erosion
- Light to Moderate Erosion
- Heavy to Excessive Erosion
- Geological Erosion
- Unclassified

SCALE IN MILES
1 0 1 2 3 4 5

FIGURE 4
EROSION CONDITION MAP
EPHRAIM WATERSHED (A-3)
Sevier River Basin
Utah
March 1968

AGRICULTURAL WATER MANAGEMENT

Supply-frequency studies indicate there is an average annual root-zone water supply deficit of 3,070 acre-feet.

Distribution systems need improvement. An estimated system loss of 30 percent contributes to water deficits. A lack of water measurement and control devices and poor regulation contribute to annual root-zone deficits. The main distribution canal of Ephraim Irrigation Company also serves as the flood channel for the lower reaches of Ephraim Creek. This compounds the water management problems with the flood disposal problem.

On-farm efficiencies need improvement through land leveling, sprinkler irrigation, ditch lining, installation of pipelines, and irrigation water management.

LAND TREATMENT NEEDS

Land treatment and improved management are needed to correct unsatisfactory watershed conditions resulting from excessive erosion and unstable soils. This will help reduce sediment yields and lower flood peaks.

Land treatment needs for irrigated lands are orientated around water management. These needs are related to sediment deposits and conveyance problems.

P H Y S I C A L P O T E N T I A L F O R M E E T I N G N E E D S

Reservoir sites for controlling flood and sediment problems are limited by topography and foundation conditions. The needed capacities are nearly 10 times that available.

Site A3-1, Ephraim Canyon, near the present debris basin and approximately one mile southeast of Ephraim, could store approximately 300 to 500 acre-feet. Site A3-2, Willow Creek, located about five miles southeast of Ephraim on a tributary to Willow Creek, has an approximate capacity of 300 acre-feet. Site A3-3, New Canyon, is an off-channel location that could store 200 acre-feet of irrigation water. Table 7 shows the physical characteristics of major sites investigated.

TABLE 7.--Physical characteristics of major sites investigated, Sevier River Basin

Site no.	Site name	Drainage area	Capacity	Cu. yd./ac. ft.[a]
		Square miles	Acre-feet	
A3-1	Ephraim Canyon	29.7	500	250
A3-2	Willow Creek	10.2	450	300
A3-3	New Canyon	1.4	200	200

[a]Cubic yards of earth fill per acre-foot of reservoir storage.

There is potential to construct flood diversion channels and dikes on the alluvial fans. These would act as dissipators and help reduce sediment loads.

Groundwater supplies for development of irrigation wells are available in quantity and quality. However, limited rights to use this source need to be reconciled.

L O C A L I N T E R E S T I N P R O J E C T D E V E L O P M E N T

This watershed receives technical assistance through the Sanpete Soil Conservation District. The local people have organized several irrigation companies which demonstrates their abilities to effectively carry out project type developments.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT

Land treatment measures for the upper watershed area applicable for acceleration under a project are as follows: Sagebrush removal, reseeding, and trenching.

Land treatment need for the irrigated lands is primarily land leveling to cope with the buildup of sediment and associated excessive operation and maintenance costs. Ditch lining and other water management practices are also applicable to the irrigated farm lands.

STRUCTURAL MEASURES

The primary project measures are canal lining and development of additional irrigation water. Included in the potential project is 75 miles of canal lining and installation of 10 irrigation wells. Canal lining will change the transportation efficiency from 70 percent to 90 percent with an increase in irrigation water available to crop root-zone of 2,520 acre-feet. The 10 irrigation wells are planned to provide 1,800 acre-feet of water to the plant root-zone.

Identification of specific sites or structures on National Forest lands at this time does not indicate or imply that it would prove either feasible or more desirable at some future time.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

STRUCTURAL MEASURES

Construction costs for normal conditions were applied for all structural development. A 10-percent contingency factor was applied to canal lining construction costs. Sizes and quantities were determined without field investigations and based on potential consumptive use of crops in the present cropping pattern. (Table 8 and 9)

TABLE 8.--Estimated structural cost-potential development,[a] Ephraim Watershed (A-3), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Canal lining			
Ephraim Irrigation Co.	Miles	60	825,000
Willow Creek Irrig. Co.	Miles	15	179,000
Wells	Each	10	118,250
Total			1,122,250
Engineering services			134,670
Land easements & rights-of-way			400
Grand total			1,257,320

[a]Price Base 1967.

TABLE 9.--Distribution of structural cost-potential development,[a] Ephraim Watershed (A-3), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Canal lining				
Ephraim Irrigation Co.	825,000	99,000	100	924,100
Willow Creek	179,000	21,480	100	200,580
Wells	118,250	14,190	200	132,640

[a]Price Base 1967.

ENGINEERING SERVICES

The engineering services costs were estimated as 12 percent of the construction costs.

EASEMENTS AND RIGHTS-OF-WAY

Included is a minimal amount for legal and near negligible easement costs. Most of the developments were to be on presently used rights-of-way.

REPLACEMENT, OPERATION AND MAINTENANCE

These costs were based on the expected life and repair costs for each item. For wells, an additional power cost was added to the replacement, operation, and maintenance to reflect all annual costs as shown in Table 10.

COST ALLOCATION

The use of facilities method was used to allocate costs. (Table 11)

PROJECT ADMINISTRATION

This cost was estimated as 13 percent of the construction costs.

E F F E C T S A N D E C O N O M I C F E A S I B I L I T Y O F P O T E N T I A L D E V E L O P M E N T

Total agricultural water management benefits from all measures will be $184,470. Agriculture water management benefits accruing from lining 60 miles of Ephraim Irrigation Company's canal system will increase conveyance efficiency 20 percent. This will result in a water savings of approximately 2,000 acre-feet root-zone supply and an annual

TABLE 10.--Annual costs,[a] Ephraim Watershed (A-3), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Canal lining			
Ephraim Irrigation Co.	31,330	24,750	56,080
Willow Creek	6,800	5,370	12,170
Wells	4,500	13,650[c]	18,150
Project administration	---	---	4,560
Grand total	---	---	90,960

[a]Price Base 1967.

[b]100 yrs. @ 3¼ percent interest.

[c]Includes pumping costs.

TABLE 11.--Cost allocation and cost sharing summary,[a] Ephraim Watershed (A-3), Sevier River Basin

Item	Cost allocation		Cost sharing			
	A.W.M.	Total	Federal		Nonfederal	
			A.W.M.	Total	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Canal lining						
Ephraim Irrigation Co.	924,100	924,100	511,500	511,500	412,600	412,600
Willow Creek	200,580	200,580	110,980	110,980	89,600	89,600
Wells	132,640	132,640	14,190	14,190	118,450	118,450
Grand total	1,257,320	1,257,320	636,670	636,670	620,650	620,650

[a]Price Base 1967.

benefit of approximately $69,790. Willow Creek Irrigation Company conveyance system canal lining project will increase efficiency 20 percent and increase the average root-zone water supply by 520 acre-feet. Annual benefits would be approximately $17,920. (Table 12)

The ten proposed wells will provide a 1,800 acre-foot increase of the annual root-zone water supply. This would result in an estimated annual benefit of $63,000.

It is assumed in evaluation that there would be no land use changes in the flood plain.

The residual on-farm land treatment benefits are estimated at $33,760 per year.

Sites and measures investigated for flood damage reduction were not considered economically feasible.

Redevelopment benefits and national secondary benefits were not evaluated. Local secondary benefits were estimated at $27,672 per year.

The ratio of average annual benefits to average annual costs for all works of improvement, including primary and secondary benefits, is 2.3:1. The benefit cost ratio, excluding local secondary benefits, is 2.1:1.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Coordinated planning with Watersheds A-1, A-2, and A-4 will be necessary if current water rights are to be recognized during project development.

Additional water supplies to satisfy downstream water rights could be obtained from development of irrigation wells. The extent of well development would depend on coordinated planning with adjacent water users and water salvage from high water using vegetation.

Flood prevention and sediment control may be feasible with more intensive investigations. The reservoirs on Willow and Ephraim Creeks might be developed with multipurpose use of storage facilities.

TABLE 12.--Comparison of benefits and costs,[a] Ephraim Watershed (A-3), Sevier River Basin

Evaluation units	Average annual benefits		Total benefits	Average annual cost[b]	Benefit cost ratio
	A.W.M.	Secondary			
	Dollars	Dollars	Dollars	Dollars	
Canal lining					
Ephraim Irrigation Co.	69,790	10,470	80,260	56,080	1.4:1
Willow Creek	17,920	2,690	20,610	12,170	1.7:1
Wells	63,000	9,450	72,450	18,150	4.0:1
Land treatment residual	33,760	5,060	38,820	---	---
Project administration	---	---	---	4,560	---
Grand total	184,470	27,670	212,140	90,960	2.3:1

[a]Price Base 1967.

[b]From Table 10.

MANTI WATERSHED (A-4)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
SANPETE COUNTY, UTAH
April 1968

T H E W A T E R S H E D I N B R I E F

This watershed is located in Sanpete County, Utah, and contains 73,700 acres (Figure 5), 1.4 percent of the area of the Sevier River Basin, and is tributary to the San Pitch River. Total watershed area is divided among private lands, 35,940 acres; state lands, 5,120 acres; Federal lands administered by the Bureau of Land Management, 10,920 acres; and Manti-LaSal National Forest lands, 21,720 acres. Manti City has a population of 1,739 (1960 census), and the total watershed population is estimated at 1,763. The 1940 to 1960 Manti population trend has been declining.

Irrigated cropland includes 6,580 acres with 73 percent alfalfa and improved pasture, 20 percent small grain, 2 percent corn silage, and 5 percent idle cropland.

Average annual precipitation for the watershed varies from 11 inches in the lower elevations to 35 inches in the higher elevations. It is 11.7 inches on the irrigated croplands. The elevations range from 5,500 to 10,000 feet.

The water supply for irrigated lands comes from Manti Creek drainage and Six Mile Creek and Morrison Mine Tunnel (Watershed C-3) as transwatershed diversions. Manti City obtains culinary water from Manti Creek and springs. An irrigation well owned and operated by the city is used for exchange purposes. Other irrigation water sources are the San Pitch River and ten irrigation wells. Farmers organized as cooperators of the San Pitch River Drainage District divert water from the San Pitch River for irrigation purposes.

The soils of the watershed are: High Mountain range sites with Cryoboroll and Cryoboralf soils, 10 percent; Mountain range sites and Cryoboroll soils, Upland range sites and Argixeroll, Calcixeroll, and Haploxeroll soils, 30 percent; Semidesert range sites and Torrifluvent and Calciorthid soils, 50 percent; Wetlands that are Haplaquepts, 10 percent. The vegetation of the upper watershed is varied with portions of aspen, conifer, pinyon-juniper, oakbrush, sagebrush, and shadscale-greasewood.

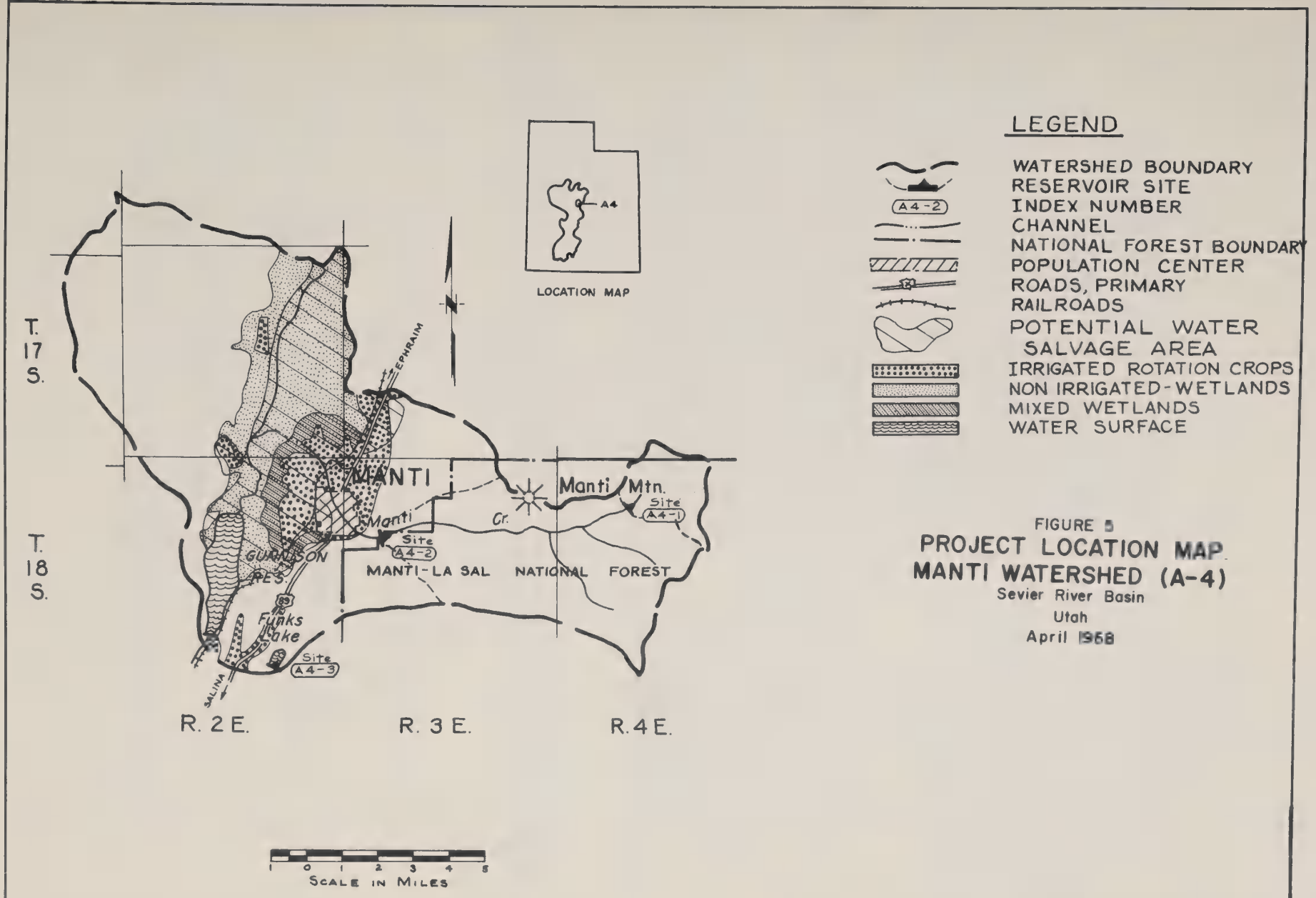


FIGURE 5

PROJECT LOCATION MAP MANTI WATERSHED (A-4)

Sevier River Basin
Utah
April 1968

The topography is typical of that found in Sanpete Valley. The Gunnison Plateau on the west is over 8,000 feet elevation while the Wasatch Plateau on the east reaches over 10,000 feet. The Sanpete Valley in this area is narrower than farther upstream.

The Gunnison Plateau front in this area reveals some of the structural movements that have helped form the topography as it is today. The disturbed belt found along the front farther north is found here also. The beds of the Flagstaff limestone are flexed sharply in a letter Z profile to the north of Dry Canyon while interestingly this same structure continues to the south in the Price River (?) conglomerate.

Across the valley in the Wasatch monocline, somewhat the same situation exists. This indicates a compressional squeeze on the valley beds which is modified by previous movements.

The strata above these zones proceeds in normal succession to the top of the plateaus.

One interesting structure is the transverse graben between Rock Canyon and Dry Canyon which has dropped approximately 1,000 feet. Strangely, at one time this block was a horst, quite a reversal of movement.

The floor of the valley is overlain by alluvium but marginal evidence indicates an anticlinal structure with complex folding underneath. The structure is also cut by considerable faulting, probably the thrust fault of the early Laramide orogeny.

WATERSHED PROBLEMS AND NEEDS

FLOOD PREVENTION AND SEDIMENT CONTROL

Manti Canyon has been under controlled grazing management since 1910. The last serious flood was in 1902, followed by smaller and less serious floods in 1906, 1908, 1909, and 1910.

The main stream channel is active with considerable gravel moving into irrigation ditches. Sediment damages are estimated to be $18,000 per year.

EROSION

Loss of topsoil and the resultant decline in vegetation is serious in many areas. This lessens the productivity and makes it increasingly difficult to restore a good vegetation-soil-water hydrologic relationship. Steep slopes and high intensity rainfall add to the problem. There is heavy to excessive erosion on 13,250 acres and about 2,200 acres of geologic erosion not accelerated by man. Streambank erosion also contributes heavily to the sediment yield (Figure 6, Erosion Condition Map).

AGRICULTURAL WATER MANAGEMENT

Diurnal and short-period fluctuation in streamflow presents a problem for efficient management of the irrigation supply. For the 6,850 acres of irrigated rotation croplands, the deficit has been over 3,500 acre-feet 20 percent of the years and over 1,000 acre-feet 50 percent of the years. The average deficit occurring through all the years has been 1,500 acre-feet.

Seepage losses from distribution systems are high. Estimated conveyance efficiency is 75 percent and on-farm efficiencies are 35 percent. These can be improved through canal lining and on-farm land treatment measures.

P H Y S I C A L P O T E N T I A L F O R M E E T I N G N E E D S

Reservoir Site A4-2, Manti Debris Basin, can be used to control debris from Manti Creek. Loggers Fork Reservoir, Patten Reservoir, Funks Lake, and Jet Fox Reservoir have potential for enlargement to store additional water supplies.

Main distribution systems are mostly unlined canals which can be effectively lined with concrete.

LEGEND

- Incipient Erosion
- Light to Moderate Erosion
- Heavy to Excessive Erosion
- Geological Erosion
- Unclassified

FIGURE 6

EROSION CONDITION MAP
MANTI WATERSHED (A-4)
Sevier River Basin
Utah
August 1968

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed receives technical assistance through the Sanpete Soil Conservation District. The local people are interested in developing the watershed as they have filed an application including 43,660 acres for PL-566 assistance. The Sanpete County Soil Conservation District was the sponsor of this application. Sponsorship of a new application or amendment would likely be similar to the previous application.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT

Land treatment measures for the upper watershed areas applicable for acceleration under a project are as follows: Chaining, contour trenching and seeding, and reseeding.

Irrigated lands need leveling to achieve potential and to cope with buildup of sediment which causes excessive operation, repairs and maintenance costs. Ditch lining and other water management practices are also applicable to the irrigated farm lands.

STRUCTURAL MEASURES

Structure Site A4-2, Manti Debris Basin, can be constructed to provide 50-year sediment protection for irrigation works. Project measures include campground facilities for 10 family units and 1 group unit adjacent to the proposed reservoir site. Concrete lining of 11 miles of canals in the irrigation distribution systems will increase efficiency. Included for lining is 2 miles of the North Six Mile Irrigation system, 3 miles of the Manti Irrigation and Reservoir Company system and 6 miles of the Manti Irrigation Company system. The development of approximately 10 irrigation wells would provide a yearly root-zone supply of 1,800 acre-feet. (Table 13)

Identification of specific sites or structures on National Forest lands at this time does not indicate or imply that they would prove either feasible or most desirable at some future time.

TABLE 13 .--Structure data - storage capacity, Manti Watershed (A-4), Sevier River Basin

Item	Unit	Value or material
Site number and name		A4-2, Manti Debris Basin
Drainage area	Square miles	13.0
Estimated height of dam	Feet	40
Estimated volume of fill	Cubic yards	80,000
Principal spillway		
Type		R/C Conduit
Release rate	CSM	10
Emergency spillway		
Type		Conc.
Chance of use	Percent	2
Maximum surface area - emergency spillway level	Acres	15
Storage capacity		
Sediment	Acre-feet	260
Detention[a]	Acre-feet	50
Flood and sediment total	Acre-feet	310
Additional capacity available	Acre-feet	300[b]

[a]Freeboard.

[b]Limited by geological factors.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

STRUCTURAL DEVELOPMENTS

Construction costs for normal conditions were applied for all structural developments based on similar Utah construction costs. A 25-percent contingency factor was applied to estimated reservoir construction costs. Sizes and quantities were determined by low intensity investigations. (Table 14 and 15)

ENGINEERING SERVICES

The engineering services costs were estimated as 12 percent of the construction costs.

EASEMENTS AND RIGHTS-OF-WAY

This item includes a minimal amount reflecting legal and near negligible easement costs. Costs for purchase of exchange water for any effect to downstream users were not included.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs were based on the expected life and repair costs for each item. An additional cost for pumping was included for well operation and maintenance costs. The costs for operating campgrounds does not include daily cleanup operations. (Table 16)

COST ALLOCATION

The use of facilities method was used to allocate costs of the multipurpose structure. (Table 17)

TABLE 14.--Estimated structural cost-potential development,[a] Manti Watershed (A-4), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Canal lining	Miles	11	235,300
Wells	Each	10	107,500
Debris basins	Each	1	210,000
Campgrounds	Each	1	14,000
Total			566,800
Engineering services			68,010
Land easements & rights-of-way			1,050
Grand total			635,860

[a]Price Base 1967.

TABLE 15.--Distribution of structural cost-potential development,[a] Manti Watershed (A-4), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Canal lining				
Manti Irrigation Co.	145,700	17,480	100	163,280
North Six Mile Irrigation Co.	42,700	5,120	100	47,920
Manti Irrigation & Reservoir Co.	46,900	5,630	100	52,630
Wells	107,500	12,900	500	120,900
Reservoirs and developments				
Site A4-2, Manti Debris Basin	210,000	25,200	200	235,400
Campgrounds	14,000	1,680	50	15,730

[a]Price Base 1967.

TABLE 16.--Annual costs,[a] Manti Watershed (A-4), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Canal lining			
Manti Irrigation Co.	5,540	4,370	9,910
North Six Mile Irrigation Co.	1,620	1,430	3,050
Manti Irrigation & Reservoir Co.	1,780	1,410	3,190
Wells	4,100	10,400	14,500
Reservoir and developments			
Site A4-2, Manti Debris Basin	7,980	710	8,690
Campgrounds	530	420	950
Project administration	---	---	2,500
Grand total	---	---	42,790

[a]Price Base 1967.

[b]100 yrs. @ 3¼ percent interest.

TABLE 17.--Cost allocation and cost sharing summary,[a] Manti Watershed (A-4), Sevier River Basin

Item	Cost allocation				Cost sharing							
	Purpose				Federal				Nonfederal			
	Sediment control	Recreation	A.W.M.	Total	Sediment control	Recreation	A.W.M.	Total	Sediment control	Recreation	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Canal lining												
Manti Irrigation Co.	---	---	163,280	163,280	---	---	90,330	90,330	---	---	72,950	72,950
North Six Mile Irrigation Co.	---	---	47,920	47,920	---	---	26,470	26,470	---	---	21,450	21,450
Manti Irrigation & Reservoir Co.	---	---	52,630	52,630	---	---	29,080	29,080	---	---	23,550	23,550
Wells	---	---	120,900	120,900	---	---	12,900	12,900	---	---	108,000	108,000
Reservoirs & developments												
Site A4-2, Manti Debris Basin	235,400	---	---	235,400	235,200	---	---	235,200	200	---	---	200
Campgrounds	---	15,730	---	15,730	---	8,680	---	8,680	---	7,050	---	7,050
Grand total	235,400	15,730	384,730	635,860	235,200	8,680	158,780	402,660	200	7,050	225,950	233,200

[a]Price Base 1967.

PROJECT ADMINISTRATION

This cost was estimated as 13 percent of the construction costs.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

Canal lining planned for Manti Irrigation Company and North Six Mile Irrigation Company would increase conveyance efficiency 15 percent with a net increased water supply to the crop root-zone of 543 and 215 acre-feet, respectively. These increased supplies will produce $19,550 and $7,740 in annual benefits, respectively. Canal lining for the Manti Irrigation and Reservoir Company will increase its conveyance efficiency by 20 percent and would result in 110 additional acre-feet of root-zone water. The annual benefit will be $3,960.

No residual agricultural water management benefits from land treatment measures were calculated.

To further satisfy irrigation water needs, 10 wells will be installed to supply an estimated 1,800 acre-feet of root-zone water with an annual benefit of $64,800. (Table 18)

Total benefits from all agricultural water management measures are $96,050.

Site A4-2 will provide capacity for a 50-year flood occurrence and for 50 years sediment containment. Flood damage reduction would be $17,980 per year primarily from lower sediment cleanout costs and increased water-use efficiency.

Campground facilities located near Site A4-2, Manti Debris Basin, are planned as part of the project. Recreation benefits from the 10 family units and 1 group unit are $2,200 annually.

Regulation of streamflows may provide fishing benefits at Site A4-2, Manti Debris Basin, for a portion of its 50-year life, but no economic analysis or cost estimates were made.

Change in land use or land enhancement to agriculture on the flood plain were not considered.

Redevelopment benefits and national secondary benefits were not evaluated.

TABLE 18.--Comparison of benefits and costs for structural measures,[a] Manti Watershed (A-4), Sevier River Basin

Evaluation units	Average annual benefits				Total benefits	Average annual cost[b]	Benefit cost ratio
	Flood damage reduction	Recreation	A.W.M.	Local secondary			
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	
Canal lining							
Manti Irrigation Co.	---	---	19,550	2,930	22,480	9,910	2.3:1
North Six Mile Irrigation Co.	---	---	7,740	1,160	8,900	3,050	2.9:1
Manti Irrigation & Reservoir Co.	---	---	3,960	590	4,550	3,140	1.5:1
Wells	---	---	64,800	9,720	74,520	14,500	5.1:1
Reservoir & developments							
Site A4-2, Manti Debris Basin	17,980	---	---	2,700	20,680	8,690	2.4:1
Campgrounds	---	2,200	---	330	2,530	950	2.7:1
Project administration	---	---	---	---	---	2,500	---
Grand total	17,980	2,200	96,050	17,430	133,660	42,790	3.1:1

[a]Price Base 1967.

[b]From Table 16.

Local secondary benefits associated with all project measures are $17,430.

The ratio of average annual benefits to average annual costs for all works of improvement, including primary and local secondary benefits is 3.1:1. The benefit cost ratio excluding local secondary benefits is 2.7:1.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Increased storage capacities of Loggers Fork Reservoir, Patten Reservoir, Funks Lake, and Jet Fox Reservoir may be possible features for a PL-566 project. In addition to their enlargement, associated developments such as campgrounds and fisheries may be included.

Agricultural water management features could be varied with additional analysis of downstream effects. These may include additional lining and well development.

Additional municipal water development for the city of Manti may be included in a PL-566 project through multiple-use storage of other water resource developments.

LEVAN WATERSHED (B-1 & B-2)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
JUAB COUNTY, UTAH
November 1966

THE WATERSHED IN BRIEF

The Levan Watershed (B-1 & B-2) is 10 miles south of Nephi, Utah, in the southeastern part of Juab County. The two small communities of Levan and Mills, population 421 and 32, respectively, are located in the irrigated area of the watershed.

Pigeon, Chicken, Deep, Little Salt, and Criss Creeks provide irrigation water to the Levan area. Return flows are stored in Chicken Creek Reservoir (called locally and named in this report as Juab Lake Reservoir) which serves the Mills irrigated area.

U. S. Highway 91, proposed I-70, and a branch of the Union Pacific Railroad traverse the cropland area.

The watershed is approximately square, averaging about 14½ miles in length and width, and encompassing 142,800 acres (Figure 7) of which 33, 790 are in the Uinta National Forest.

The watershed contributes about 3,120 acre-feet annually in surface and groundwater to the Sevier River.

Soils in the cropland area lie on slopes of 1 percent to 6 percent. They are deep, medium to fine textured and with the exception of the areas near Juab Lake Reservoir and bordering the Sevier River, are well drained. Water-holding capacities vary from 9 to 11 inches in a 5-foot profile.

Soils in the noncultivated areas are generally of medium texture, well drained, and with the exception of rock outcrops and shale areas are moderately deep. Slopes vary from 10 percent to 70 percent with most slopes between 30 percent and 50 percent. Water-holding capacities vary between 3 inches and 8 inches in a 5-foot profile. Vegetation is predominantly brush mixed with juniper, pinyon and grass below elevations of 7,000 feet. Above this elevation vegetation is a mixture of conifer, aspen, oakbrush, and grass.

Present land use is as follows: Irrigated cropland, 6 percent (8,600 acres); dry cropland, 15½ percent (22,100 acres); phreatophytes,

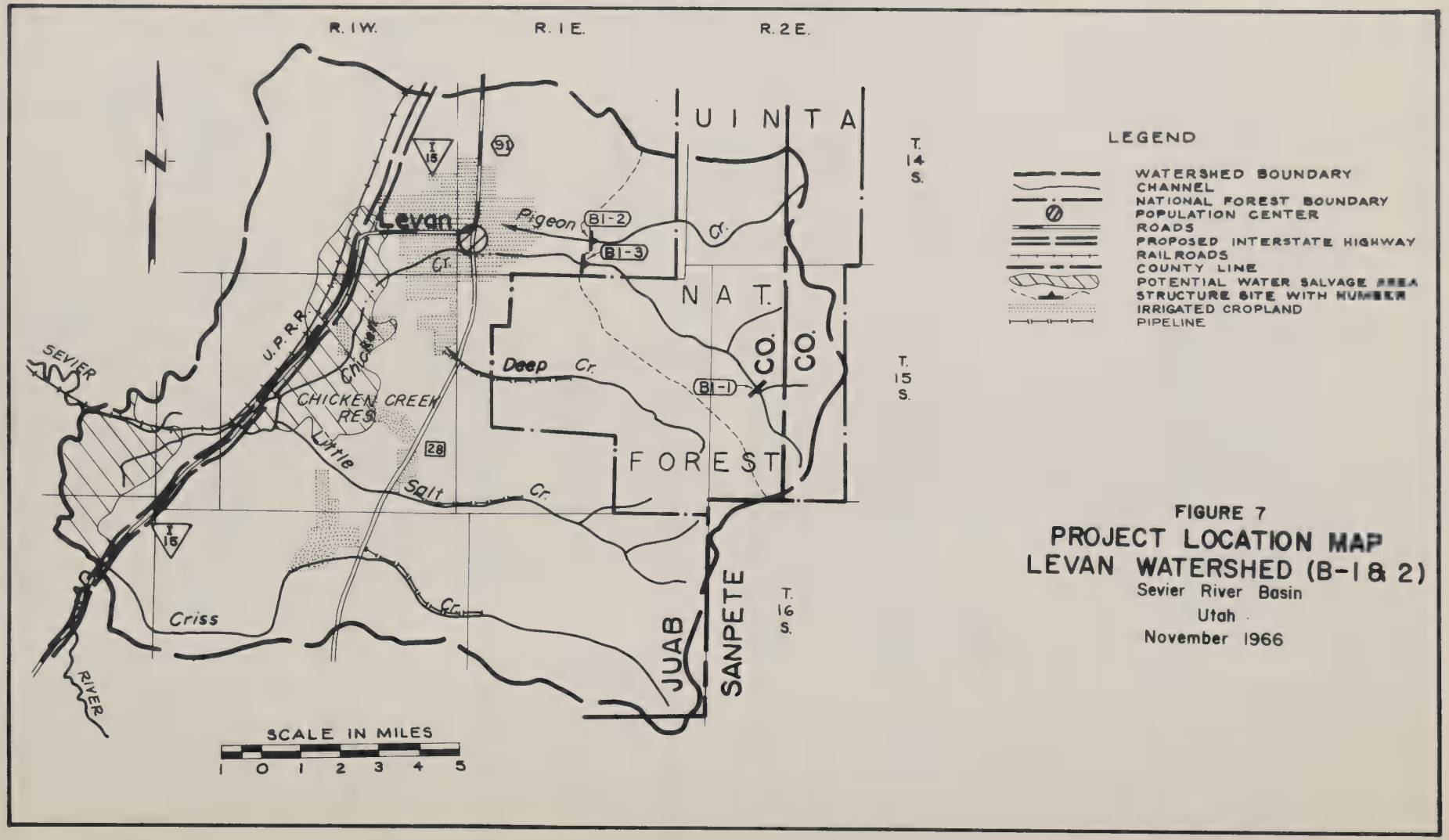


FIGURE 7
PROJECT LOCATION MAP
LEVAN WATERSHED (B-1 & 2)
Sevier River Basin
Utah
November 1966

3½ percent (5,000 acres); and forest and rangeland, 75 percent (107,100 acres). Most of the dry cropland is irrigable. With the exception of dry farming, all important economic activities are centered around general livestock farming.

Annual precipitation varies from 10 inches near Mills to 25 inches in the higher mountains.

W A T E R S H E D P R O B L E M S A N D N E E D S

FLOOD PREVENTION

Direct floodwater damages from Pigeon and Chicken Creeks are estimated to be $2,000 per year. This includes damages to canals, land, roads, and bridges. Minor damaging floods also occur in Deep, Little Salt, and Criss Creeks but these were not evaluated.

EROSION AND SEDIMENT

Loss of topsoil and the resultant decline in vegetation is serious on many areas. Pigeon and Chicken Creeks produce between 15 and 24 acre-feet of sediment per year. Estimates were not made for Deep, Little Salt, and Criss Creeks, but sediment is a minor problem in each of these. Irrigation system maintenance costs due to sedimentation are excessive. The decline in irrigation efficiency because of sediment deposition in head ditches and on land areas contribute to the water shortage. (Figure 8)

RECREATION

Camping, picnicking and other recreation facilities accessible to U. S. Highway 91 are needed in the watershed.

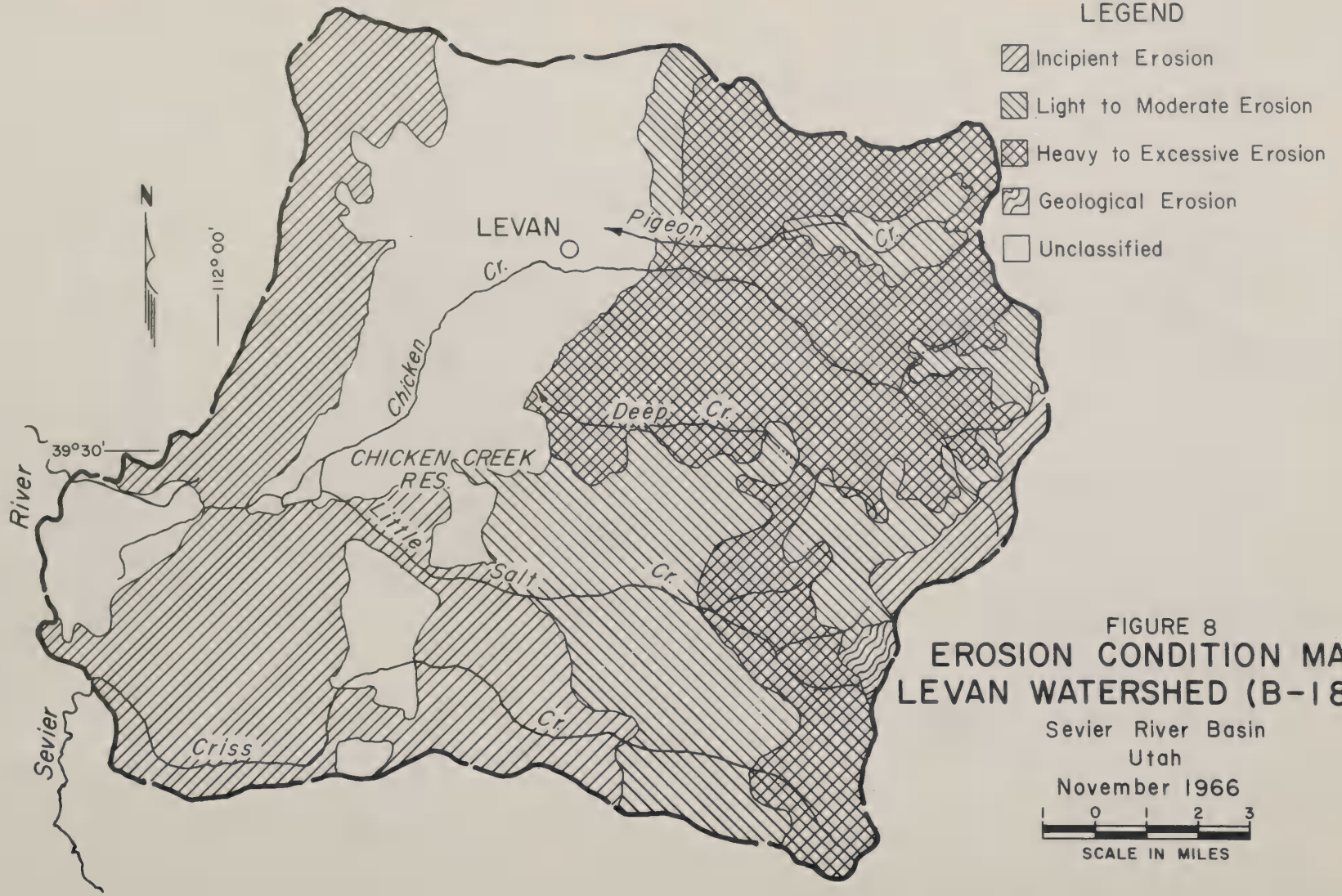


FIGURE 8
EROSION CONDITION MAP
LEVAN WATERSHED (B-1&2)
Sevier River Basin
Utah
November 1966

AGRICULTURAL WATER MANAGEMENT

Irrigation water supplies are inadequate about two-thirds of the time. The average annual shortage is 4,600 acre-feet of root-zone soil moisture.

In Deep, Little Salt and Criss Creeks, channel losses in the mountain areas are high.

The Levan Irrigation Company has lined about one-third of their distribution system but more is needed.

Very little land leveling has been done and there is general need for this practice. Low on-farm irrigation efficiencies are contributing to the water shortages.

Lack of regulation of irrigation water supplies is reflected in both excessive diurnal fluctuation and high early season runoff as compared to a shortage of water in the late irrigation season.

About 16,500 acres of potentially irrigable land does not have a water supply.

P H Y S I C A L P O T E N T I A L F O R M E E T I N G N E E D S

A program of water development, control, and salvage is possible to improve the irrigation based economy. A full water supply for the presently irrigated lands will require complete development of the water resources. Over 16,000 acres of good quality irrigable lands cannot be irrigated unless additional water supplies are imported.

Land treatment for watershed protection is necessary to preserve and improve the topsoil and vegetative resources. They would also reduce the floodwater and sediment problems to a level where floodwater detention and sediment retention structures at or above the irrigation diversions on Pigeon and Chicken Creeks become practical.

Floodwater and sediment control structures are needed at the mouths of Pigeon and Chicken Creeks. These structures should retain sediment, stabilize the daily variations in flow and provide a water base for recreation.

A multiple-purpose water-storage reservoir site exists on the upper section of Chicken Creek. This should be developed to store the nonirrigation season runoff for irrigation, flood control, sediment

retention and recreation purposes. Irrigation water releases need to be programmed to prolong the irrigation season of the Levan Irrigation Company.

The distribution systems that divert water from the mountain streams need extensive improvements. In addition to the structures to stabilize the daily flows in Pigeon and Chicken Creeks, the diversions in Criss, Deep, and Little Salt Creeks should be moved upstream to avoid excessive water losses and erosion in the lower reaches. Irrigation wells are needed to develop the groundwater reservoir for supplemental irrigation water. All irrigation systems need canal lining or pipeline programs to minimize seepage losses and operation and maintenance costs.

Land treatment on the irrigated lands must be installed if water losses are to be kept at a minimum and full advantage taken of the water resources. Needed measures include: Sprinkler irrigation systems, ditch lining, land leveling, and irrigation water management.

Full development of the water resources for the Mills area will require draining Juab Lake Reservoir and the surrounding wet meadows. This would partially be accomplished by the developments mentioned above. Full accomplishment would require changing the irrigation-water supply for Juab Lake Irrigation Company from the present surface reservoir to utilization of the groundwater reservoir in the area. Water pumped from this groundwater reservoir would offset the downstream effects of improved irrigation methods. Any additional pumping needed to control the groundwater reservoir to maintain drainage of the wet area would be available for use on the irrigable lands.

Recreation opportunities exist at each reservoir, and are especially desirable near U. S. Highway 91. The present Juab Lake Reservoir with a smaller capacity might be retained for recreation purposes and a waterfowl resting area.

L O C A L I N T E R E S T I N P R O J E C T D E V E L O P M E N T

This watershed receives technical assistance through the Juab County Soil Conservation District.

About one-half the area is now included in a formal application for planning assistance under Public Law 566. Sponsors signing this application are: The Juab Soil Conservation District, Levan Town, Juab County, and the Levan Irrigation Company. The application is also

endorsed by the Levan Cattlemen's Association, the Levan Land Company, and the Deep Canyon Land Company.

To carry out a project as outlined here, all of the area should be included in this application. Additional sponsors for the larger area would include Mills Town and the Juab Lake Irrigation Company.

Consideration was given to desires of the local people, but was not the basis of project evaluation.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT

Land treatment on irrigated land would include land leveling, ditch lining, and sprinkler irrigation systems. Land treatment for watershed protection would include erosion control and revegetation measures.

STRUCTURAL MEASURES

Multiple-purpose reservoirs, Site Nos. B1-2 and B1-3, constructed near the mouths of Pigeon and Chicken Creeks would need a capacity of about 455 acre-feet each if a sediment cleanout program were followed. The multiple-purpose reservoir, Site No. B1-1, in the upper drainage of Chicken Creek would provide approximately 1,940 acre-feet of storage for floodwater detention, sediment, recreation and irrigation. (Table 19)

Canal lining for an additional 16 miles of the Levan Irrigation Company system is needed.

Pipelines in Criss, Deep, and Little Salt Creeks for a combined distance of about 16 miles is needed. Irrigation wells with a combined capacity of 81 c.f.s. would be located throughout the irrigated and wet areas above and around Juab Lake Reservoir.

Identification of specific sites or structures on National Forest lands at this time does not indicate or imply that they would prove either feasible or more desirable at some future time.

TABLE 19.--Reservoir data, Levan Watershed (B-1 & B-2), Sevier River Basin

Item	Unit	Site		
		Chicken Creek Upper B1-1	Pigeon Creek B1-2	Chicken Creek Lower B1-3
Class of structure		"C"	"C"	"C"
Drainage area	Square miles	8.0	9.5	16.6
Estimated height of dam	Feet	80	50	50
Estimated volume of fill	Cubic yards	95,500	119,500	119,500
Principal spillway				
Type		R/C Conduit	R/C Conduit	R/C Conduit
Release rate	C.F.S.	10	300	300
Emergency spillway				
Type		Rock	Rock	R/C Conduit
Chance of use	Percent	1	1	1
Maximum surface area - emergency spillway level	Acres	92	20	20
Storage				
Floodwater and sediment	Acre-feet	50	295	320
Recreation	Acre-feet	660	150	115
Irrigation storage	Acre-feet	1,200	10	20
Total storage	Acre-feet	1,940	455	455
Surface of recreational pool	Acres	39	12	12

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

RESERVOIRS

Capacities of Site No. B1-2, Pigeon Creek, and Site No. B1-3, Lower Chicken Creek, were determined on the basis of expected sediment and flood volumes, needed regulation of streamflow and needed capacity for a minimum fish pool. Flood and sediment yields are based on reconnaissance geologic and hydrologic data along with data supplied by the Levan Irrigation Company. The cost estimate is based on a reconnaissance topographic map and a unit price per cubic yard of earth fill. (Table 20 & 21)

The capacity of Site No. B1-1, Upper Chicken Creek, is based on the expected nonirrigation season flow need for regulation of snowmelt runoff and requirements for a minimum fish pool. The cost estimate is based on a topographic map made from aerial photographs and a unit price per cubic yard of earth fill.

CAMPGROUNDS

The estimates for campgrounds and other recreation facilities at each reservoir are based on present costs for similar developments.

CANAL LINING

Canal lining for the Levan Irrigation Company system is one method of seepage control and water management expected to be installed. A map of the system was used to determine lengths. Canal sizes and costs were estimated, based on the past lining program of the company.

PIPELINES

Pipelines for developing the water in Deep, Little Salt, and Criss Creeks were planned as follows: Layout, lengths, and slopes were taken from 1:250,000 scale topographic maps. Design was based on the expected yield at the pipeline intakes. The cost estimate is based on cost of

TABLE 20.--Estimated structural cost-potential development,[a] Levan Watershed (B-1 & B-2), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Multiple-purpose reservoir	Each	3	364,000
Canal lining	Miles	16	180,800
Pipelines	Miles	14	189,700
Wells	Each	27	290,300
Campgrounds	Each	3	42,000
Total			1,066,800
Engineering services			133,400
Land easements & rights-of-way			268,050
Grand total			1,468,250

[a]Price Base 1966.

TABLE 21.--Distribution of structural cost-potential development,[a] Levan Watershed (B-1 & B-2), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Reservoirs	364,000	45,500	500	410,000
Canal lining	180,800	22,600	100	203,500
Pipelines	189,700	23,700	100	213,500
Wells	290,300	36,300	267,300	593,900
Campgrounds	42,000	5,300	50	47,350

[a]Price Base 1967.

pipe plus expected installation cost. Also included is a lump sum estimate for inlet structures.

WELLS

Well construction and related costs are based on well costs in similar areas.

ENGINEERING SERVICES

Engineering services are estimated to be 12.5 percent of the construction costs.

EASEMENTS AND RIGHTS-OF-WAY

Most easements and rights-of-way for project measures are presently owned by the sponsors or require acquisition of public land. An exception to this is the area near Juab Lake Reservoir. In some areas, the effect of the overall project will require purchase of these lands or reimbursement of present property holders for reduced land values due to lowering the water table and drying up wet meadows. Estimates are based on expected value of the land with and without the project.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs are based on the expected life and repair costs for each individual measure. (Table 22)

COST ALLOCATION

The use of facilities method was used to allocate costs of multiple-purpose structures. (Table 23)

TABLE 22.--Annual costs,[a] Levan Watershed (B-1 & B-2), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Reservoirs	13,900	1,800	15,700
Canal lining	6,900	5,400	12,300
Pipelines	7,240	5,700	12,940
Wells	20,100	4,400	24,500
Campgrounds	1,610	800	2,410
Project administration	---	---	4,500
Grand total	---	---	72,350

[a]Price Base 1967.

[b]100 yrs. @ 3¼ percent interest.

TABLE 23 .--Cost allocation and cost sharing summary,[a] Levan Watershed (B-1 & B-2), Sevier River Basin

Item	Cost allocation				Cost sharing							
	Purpose				Federal				Nonfederal			
	Flood prevention	Recreation	A.W.M.	Total	Flood prevention	Recreation	A.W.M.	Total	Flood prevention	Recreation	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Reservoirs	102,500	131,200	176,300	410,000	102,400	72,850	97,750	273,000	100	58,350	78,550	137,000
Canal lining	---	---	203,500	203,500	---	---	113,000	113,000	---	---	90,500	90,500
Pipeline	---	---	213,500	213,500	---	---	118,600	118,600	---	---	94,900	94,900
Wells	---	---	593,900	593,900	---	---	36,300	36,300	---	---	557,600	557,600
Campground	---	47,350	---	47,350	---	26,300	---	26,300	---	21,050	---	21,050
Grand total	102,500	178,550	1,187,200	1,468,250	102,400	99,150	365,650	567,200	100	79,400	821,550	901,050

[a]Price Base 1967.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

With the level of development described, 100-year flood protection would be afforded areas below Pigeon and Chicken Creeks. The average annual root-zone deficit in the irrigated area would be reduced from 4,600 acre-feet to about 170 acre-feet. Developments at the three reservoir sites would provide much needed recreation.

The combined effect of land treatment on irrigated lands and the structural measures will salvage approximately 4,000 acre-feet of the water now consumptively used in the Juab Lake Reservoir and associated wet area.

Providing the Mills area with well water will overcome the current irrigation water shortages.

The improved irrigation methods will reduce the annual flow to the Sevier River by 160 acre-feet. Offsetting effects are through reduction of nonproductive consumptive use of the wetlands near Mills. However, wetland drainage will reduce use by wildlife. The extent of this has not been evaluated.

The combined average annual benefits for flood-damage reduction were estimated to be $5,800 with an additional benefit expected to accrue through accomplishment of needed land treatment measures.

Recreational benefits of $22,700 would accrue through expected use of the campground and fisheries.

Benefits from agricultural water management measures would be $119,100 with an addition of $37,000 for land treatment on irrigated lands.

Local secondary benefits would be $27,690 annually.

Benefits from reduced existing highway maintenance costs and construction costs of proposed I-70 were not evaluated.

Summaries of benefits, costs and comparisons are listed in Table 24.

TABLE 24.--Comparison of benefits and costs for structural measures,[a] Levan Watershed (B-1 & B-2), Sevier River Basin

Evaluation units	Average annual benefits				Total benefits	Average annual cost[b]	Benefit cost ratio
	Flood damage reduction	Recreation	A.W.M.	Local secondary			
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	
Reservoirs	5,800	6,300	5,430	2,630	20,160	15,700	1.3:1
Canal lining	---	---	19,800	2,970	22,770	12,300	1.8:1
Pipelines	---	---	22,070	3,310	25,380	12,940	2.0:1
Wells	---	---	71,800	10,770	82,570	24,500	3.4:1
Campgrounds	---	16,400	---	2,460	18,860	2,410	7.8:1
Residual land treatment	---	---	37,000	5,550	42,550	---	---
Project administration	---	---	---	---	---	4,500	---
Grand total	5,800	22,700	156,100	27,690	212,290	72,350	2.9:1

[a]Price Base projected long term for benefits, operation, and maintenance and 1966 price base for installation cost.

[b]100 years at 3¼ percent interest.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Approximately 16,500 acres of additional land could be irrigated if water were imported. The effect of additional irrigation on water salvage would be important and should be evaluated prior to importation of any water.

Consideration should be given to the possible conversion of the present Juab Lake Reservoir into a wildlife and recreation development. Depletion of water supplies through such a development would have a profound impact on the hydrology of the proposed opportunity.

SCIPIO WATERSHED (B-4)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
MILLARD COUNTY, UTAH
November 1966

THE WATERSHED IN BRIEF

The Scipio Watershed is located in the eastern part of Millard County. U. S. Highway 91 bisects the lower part of the watershed which is known as Round Valley. Within this valley lies the town of Scipio (population 328, census of 1960) and the irrigated area of the watershed.

The upper watershed consists of Ivy Creek, Scipio Lake Reservoir, Round Valley Creek and their respective drainages. Ivy Creek flows northerly, emptying into Scipio Lake Reservoir. Round Valley Creek flows northerly from the reservoir to the irrigated area. (Figure 9)

The watershed has no surface drainage outlet but groundwater flows to the Sevier River along fault zones and solution channels in the limestone bedrock.

The watershed is 24 miles long and averages 7 miles in width. It contains 102,900 acres or 160.8 square miles. The Fishlake National Forest within the boundary of the watershed contains 32,180 acres.

Soils in the mountain areas are formed from sedimentary rocks, generally less than 36 inches in depth, of medium texture, and are on slopes of 25 percent to 70 percent. Most slopes would be between 40 percent and 50 percent. Vegetation is mostly conifers in the higher areas, with oakbrush and pinyon-juniper occurring in the lower areas.

Soils in the rangeland area vary from medium to coarse in texture, are well drained and occur on slopes of 1 percent to 25 percent. Vegetation varies from oakbrush and juniper to sagebrush, greasewood, grasses, and annual weeds.

Valley soils are deep and, with the exception of the reservoir and adjacent wet area, are well drained. Soil texture is medium and slopes vary from 1 percent to 4 percent. Vegetation consists of sagebrush, greasewood, juniper, grasses, and annual weeds in noncultivated areas. Principal crops in cultivated areas are alfalfa and small grain. The wet area supports an assortment of meadow grass, wiregrass, sedges, and other wetland vegetative types.

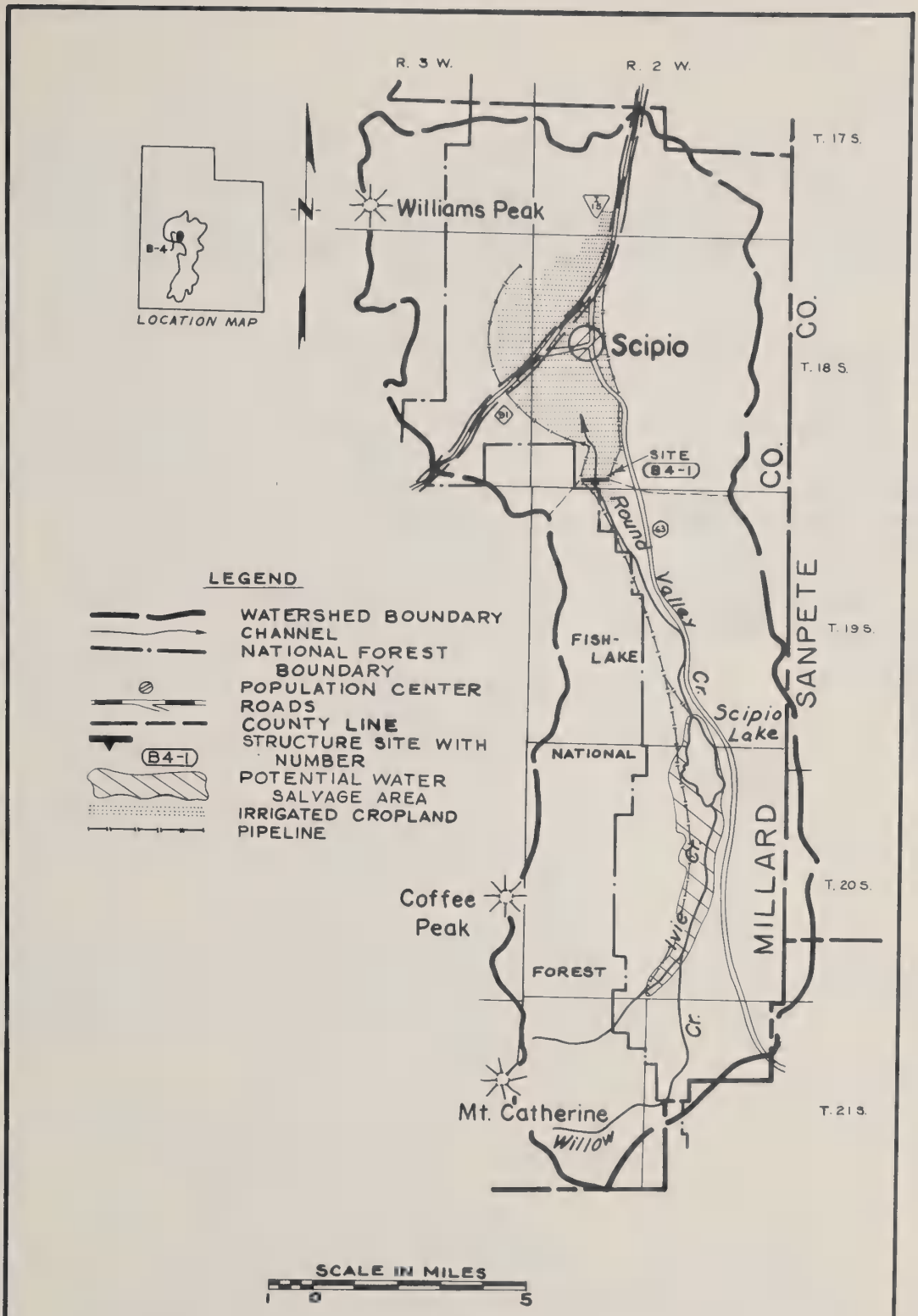


FIGURE 9
PROJECT LOCATION MAP
SCIPIO WATERSHED(B-4)
Sevier River Basin
Utah
November 1966

Present land use is as follows: Irrigated cropland, 4 percent (4,100 acres); dry cropland, 18 percent (18,500 acres); wet pasture, 2 percent (2,100 acres); and forest and rangeland, 76 percent (78,200 acres).

Annual precipitation varies from 11 inches north of Scipio to 35 inches in the higher mountains.

The principal economic activities are dry irrigated farming and general livestock farming. The livestock enterprises generally utilize all the products of the irrigated area while the dryland crops, generally wheat, are sold for cash.

The trend in recent years has been toward consolidation of farm units and a decrease in population. Much of the dry cropland is in the soil bank and has been converted to grass.

WATERSHED PROBLEMS AND NEEDS

EROSION AND SEDIMENT

About two-thirds (68,500 acres) of the watershed has no erosion or sediment problems. Of the remaining one-third, erosion is incipient on 65 percent (22,400 acres) and light to medium on 35 percent (12,000 acres). Small areas throughout, mostly stream channels, have heavy to excessive erosion. These areas are shown on the Erosion Condition Map. (Figure 10)

AGRICULTURAL WATER MANAGEMENT

Irrigation water supplies are inadequate more than 9 years in 10. Of the 9,800 acre-foot potential consumptive use for presently irrigated lands, there is an average annual shortage of 3,330 acre-feet. The principal reasons are high losses in the irrigation distribution system and high use of water in Scipio Lake Reservoir and the adjacent wet area. Low on-farm irrigation efficiencies are also a contributing factor. The overall effect of the above conditions results in only about 3,010 acre-feet of the 19,440 acre-feet average yield above the reservoir being consumptively used by irrigated crops.

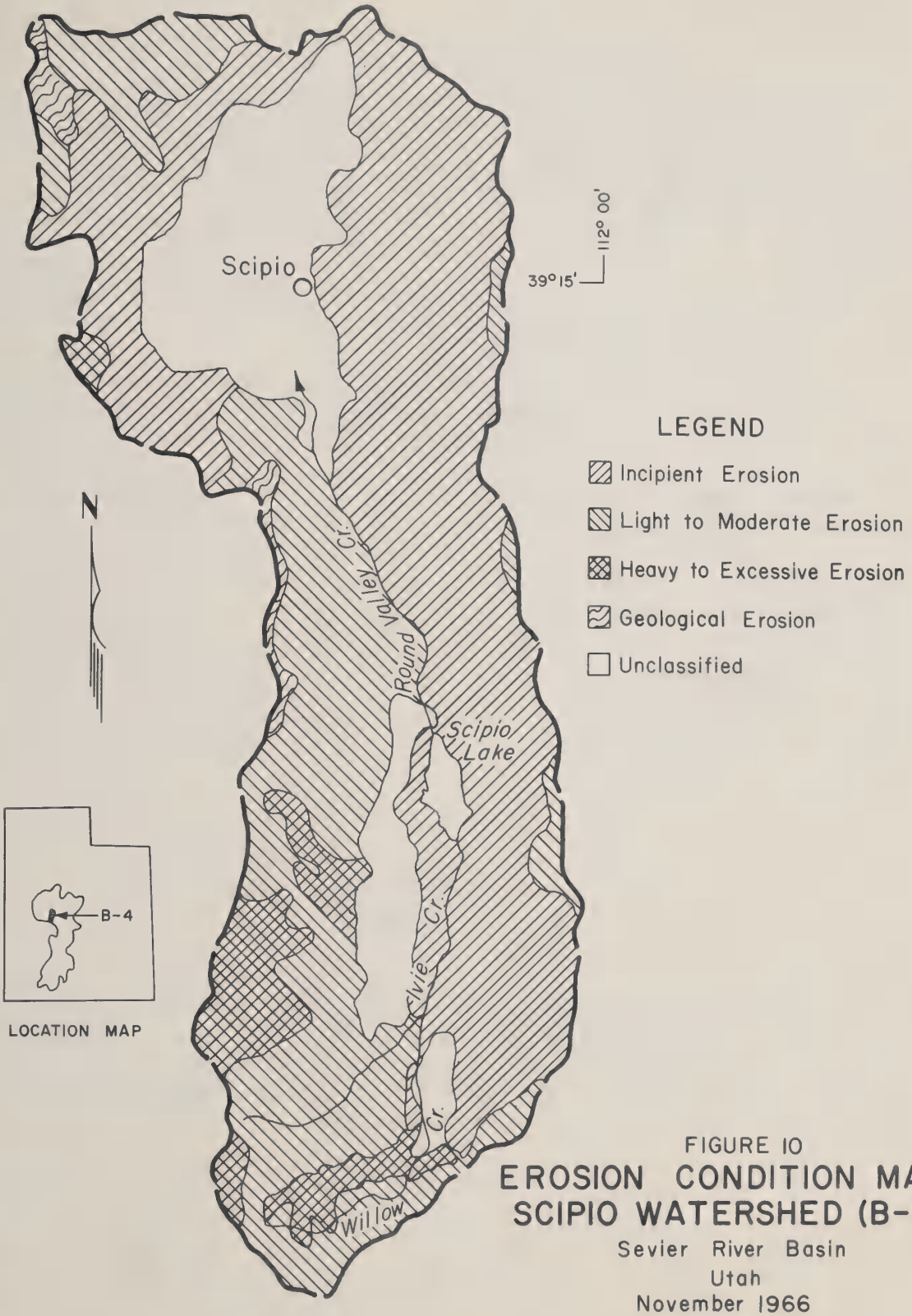


FIGURE 10

EROSION CONDITION MAP SCIPIO WATERSHED (B-4)

Sevier River Basin

Utah

November 1966

RECREATION

Presently available recreation facilities are not adequate to meet the present demands imposed on the area.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Land treatment on mountain and rangeland could help control the existing erosion and would prevent many areas from developing erosion problems.

Water supplies, if properly controlled and utilized, are adequate to reduce the deficit on irrigated land to a 4-year in 10 occurrence and to reduce the size of deficits. Water would be available 6 out of 10 years to irrigate grassland within and adjacent to the irrigated area. Abandoning the present Scipio Lake Reservoir and draining the dead water lake and surrounding wet meadows would allow the local residents to have better control over the use of the water now being consumed in this area. Replacing this inefficient situation with a new reservoir nearer to Scipio could provide storage and regulation for the irrigation water supplies. It could also provide a fishery and a base for a picnic and campground area. (Table 25)

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed receives technical assistance through the Millard County Soil Conservation District. The District, the town of Scipio and the Scipio Irrigation Company recognize the problems and the need for a project. This interest could result in a formal application for assistance in the development of a small watershed project.

TABLE 25.--Reservoir data, Scipio Watershed (B-4), Sevier River Basin

Item	Unit	Value or material
Site number		B4-1
Drainage area	Square miles	27
Estimated height of dam	Feet	80
Estimated volume of fill	Cubic yards	1,050,000
Principal spillway		
Type		R/C Conduit
Release rate	C.F.S.	50
Emergency spillway		
Type		Rock
Chance of use	Percent	1
Maximum surface area - emergency spillway level	Acres	140
Storage		
Sediment		Minor
Recreation	Acre-feet	110
Surface area of recreational pool	Acres	18
Irrigation	Acre-feet	5,040
Total storage	Acre-feet	5,150

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT MEASURES

Needed land treatment measures on forest and rangeland are fencing, water developments, revegetation measures, contour trenching and gully plugs to control critical erosion.

To best utilize potential improvements in delivery systems, most of the irrigated cropland will require leveling in order to increase irrigation efficiencies. On-farm ditch lining is needed in all irrigated areas. These land treatment measures will permit more efficient irrigation water management.

STRUCTURAL MEASURES

Canal lining is needed for the entire 35 mile irrigation delivery system. Drainage of the 1900-acre wet area, drainage and abandonment of the Scipio Lake Reservoir, and the construction of another reservoir on a more favorable site near town will allow approximately a 70-percent increase in water delivery to the irrigated area.

The close proximity of a reservoir to Scipio and to U. S. Highway 91 and proposed I-15 will provide an excellent opportunity for water-based recreation and insure adequate use to justify a campground and picnic area.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

CANAL LINING

Layout of an irrigation system to meet the needs was made on aerial mosiacs. (Table 26, 27, and 28)

TABLE 26.--Estimated structural cost-potential development,[a] Scipio Watershed (B-4), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Canal lining	Miles	35	465,200
Drainage	Miles	4	52,500
Reservoir	Number	1	791,000
Campground	Number	1	17,800
Total			1,326,500
Engineering services			165,850
Land easements and rights-of-way			387,200
Grand total			1,879,550

[a]Price Base 1967.

TABLE 27 .--Distribution of structural cost-potential development,[a] Scipio Watershed (B-4), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Canal lining	465,200	58,150	100	523,450
Drainage	52,500	6,600	382,000	441,100
Reservoir	791,000	98,900	3,900	893,800
Campground	17,800	2,200	1,200	21,200

[a]Price Base 1967.

TABLE 28.--Annual costs,[a] Scipio Watershed (B-4), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Canal lining	17,750	14,000	31,750
Drainage	15,000	300	15,300
Reservoir	30,300	4,000	34,300
Campground	700	400	1,100
Project administration	---	---	5,600
Grand total	63,750	18,700	88,050

[a]Price Base 1967.

[b]100 years @ 3¼ percent interest.

DRAINAGE

The drainage system needed to dry up the old reservoir and adjacent wet area was estimated from aerial mosiacs.

RESERVOIR

The reservoir cost is based on a reconnaissance topographic map, and applying a unit cost to the calculated earthwork.

EASEMENTS AND RIGHTS-OF-WAY

The cost of easement and rights-of-way necessary to drain the reservoir and wet area was estimated based on the present value of wetlands and their probable future value if drained. Rights-of-way for the reservoir and picnic areas are estimated at $30 per acre. Other easements and rights-of-way are now owned by potential sponsors or are considered negligible to the feasibility of this project.

ENGINEERING SERVICES

Engineering services were estimated as 12 percent of the construction costs.

COST ALLOCATION

The use of facilities method was used to allocate costs of the structures. (Table 29)

TABLE 29.--Cost allocation and cost sharing summary,[a] Scipio Watershed (B-4), Sevier River Basin

Item	Cost allocation				Cost sharing							
	Purpose				Federal				Nonfederal			
	Flood prevention	Recreation	A.W.M.	Total	Flood prevention	Recreation	A.W.M.	Total	Flood prevention	Recreation	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Canal lining	---	---	523,450	523,450	---	---	290,750	290,750	---	---	232,700	232,700
Drainage	---	---	441,100	441,100	---	---	32,900	32,900	---	---	408,200	408,200
Reservoir	---	19,200	874,600	893,800	---	10,600	483,800	494,400	---	8,600	390,800	399,400
Campground	---	21,200	---	21,200	---	11,100	---	11,100	---	10,100	---	10,100
Grand total	---	40,400	1,839,150	1,879,550	---	21,700	807,450	829,150	---	18,700	1,031,700	1,050,400

[a]Price Base 1967.

EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

With the level of development described, the water shortage for the presently irrigated land area would be reduced from occurring 9 times in 10 years to less than 4 times in 10 years. The average root-zone deficit would be reduced from 3,300 acre-feet to 420 acre-feet per year. Surplus water could irrigate annual crops or grass 6 years in 10 providing an average of 720 acre-feet of root-zone moisture.

Benefits assigned to project measures are as follows: (1) Associated land treatment. This is composed of benefits accruing from land leveling and ditch lining less the cost to achieve these benefits. About one-half the needed land treatment would be accomplished during the project with the remainder to be done by the going program of the Millard County Soil Conservation District. The associated residual land treatment benefit claimed as project benefits is $15,900 per year. (2) Water deficit reduction benefit. A portion of this benefit was assigned to each agricultural water management measure according to its effect on relieving water shortages. The value of this benefit is based on the value of the increased production of alfalfa hay with improved water supplies. The portion of this benefit produced by canal lining, drainage and reservoir storage is $101,650 per year. (3) Reduced operation and maintenance benefit. The canal lining is expected to reduce O&M costs about $.30 per acre or $1,190 per year. (4) Call system benefit. The new reservoir located close to the irrigated area would allow the development and operation of a call system. Benefits are estimated at $1.50 per acre or $5,600 per year. (5) Benefit from water supplied to irrigate new lands. This benefit is derived from the increased production of forage on grasslands or the value of annual crops raised with surplus water. The 720 acre-feet average supply is estimated to give an annual benefit of $14,400 per year. (6) Recreation benefits. The fishery would produce benefits valued at about $100 per acre. For the 18-acre minimum fish pool, benefits would be $1,800 per year. The campground adjacent to the reservoir is estimated to produce benefits of $9,750 per year. (Table 30)

The downstream effect resulting from the project would average about 500 acre-feet increased groundwater flow to the Sevier River system. Salvage at the Scipio Lake Reservoir would be about 4,500 acre-feet with 4,000 acre-feet of increased use in Round Valley.

The water salvage program at the Scipio Lake Reservoir would virtually eliminate this waterfowl habitat. The establishment of a fishery and an increase in upland game birds at Scipio as a result of more irrigation may partially compensate for this.

TABLE 30.--Comparison of benefits and costs for structural measures,[a] Scipio Watershed (B-4), Sevier River Basin

Evaluation units	Average annual benefits			Total annual benefits	Average annual cost[b]	Benefit cost ratio
	Recreation	A.W.M.	Local secondary			
	Dollars	Dollars	Dollars	Dollars	Dollars	
Canal lining	---	44,910	6,735	51,645	31,750	1.6:1
Reservoir & drainage	1,800	77,930	11,690	91,420	49,600	1.8:1
Campground	9,750	---	1,460	11,210	1,100	10.2:1
Residual land treatment	---	15,900	2,385	18,285	---	---
Project administration	---	---	---	---	5,600	---
Grand total	11,550	138,740	22,270	172,560	88,050	2.0:1

[a]Price Base 1967.

[b]Refer to Table 28.

ALTERNATE OR ADDITIONAL POSSIBILITIES

1. The installation of a pipeline to distribute the water below the reservoir and sprinkler irrigation to service the irrigated area should be considered. This would be costly, but a more efficient use of the water resource.

2. A project not involving water salvage or the construction of a reservoir would be feasible. However, in this case a reduction in return flow to the Sevier River would result.

3. Preservation of waterfowl habitat by retaining a minimum lake at the present site might prove feasible. This would consume some of the water resources in the watershed.

SALINA CREEK WATERSHED (C-5)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
SEVIER AND SANPETE COUNTIES, UTAH
June 1968

THE WATERSHED IN BRIEF

The Salina Creek Watershed (C-5) is a tributary to the Sevier River and is located in northeastern Sevier County, 194,350 acres, and southeastern Sanpete County, 4,650 acres. Salina, with a population of 1,618 is the only community and is located in the irrigated area. The 1960 census for the watershed was 1,652 people. (Figure 11)

U. S. Highway 89 and a branch line of the Denver and Rio Grande Western Railroad traverse the cropland area. Utah Highway 4 follows Salina Canyon and Interstate 70 is following this same route.

The watershed encompasses 199,000 acres of which 145,700 acres are Fishlake National Forest lands. The cropland area, 5,050 acres, includes 2,270 acres of rotation cropland, 1,510 acres of irrigated native meadow, 1,120 acres of nonirrigated wetlands, and 150 acres of idle lands.

The watershed yields 39,130 acre-feet of water annually. The total average annual water use in the cropland area is 12,660 acre-feet per year, which is allocated in the following manner: Irrigated lands, 8,980 acre-feet; nonirrigated lands, 3,320 acre-feet; and domestic use, 360 acre-feet. The average annual outflow from the watershed is 26,470 acre-feet of surface and groundwater.

Soils in the cropland area are deep, medium to fine textured and lie on less than 1 percent to 4 percent slopes. Water holding capacity is 2 inches per foot. Drainage is generally good but there are areas of poor drainage in the bottom lands near the Sevier River.

Mountain soils are medium textured, well drained, and vary from shallow to moderately deep with rock outcrop areas. Vegetation in the higher area is aspen and conifer. Lower elevations are within the pinyon-juniper zone. Slopes vary from very steep (65-80 percent) along the breaks into the creek to the more gentle toe slopes and plateaus.

Annual precipitation varies from 10 inches near Salina to 35 inches in the high mountain areas. Elevations range from 5,100 feet at Salina to 11,000 feet in the upper watershed.

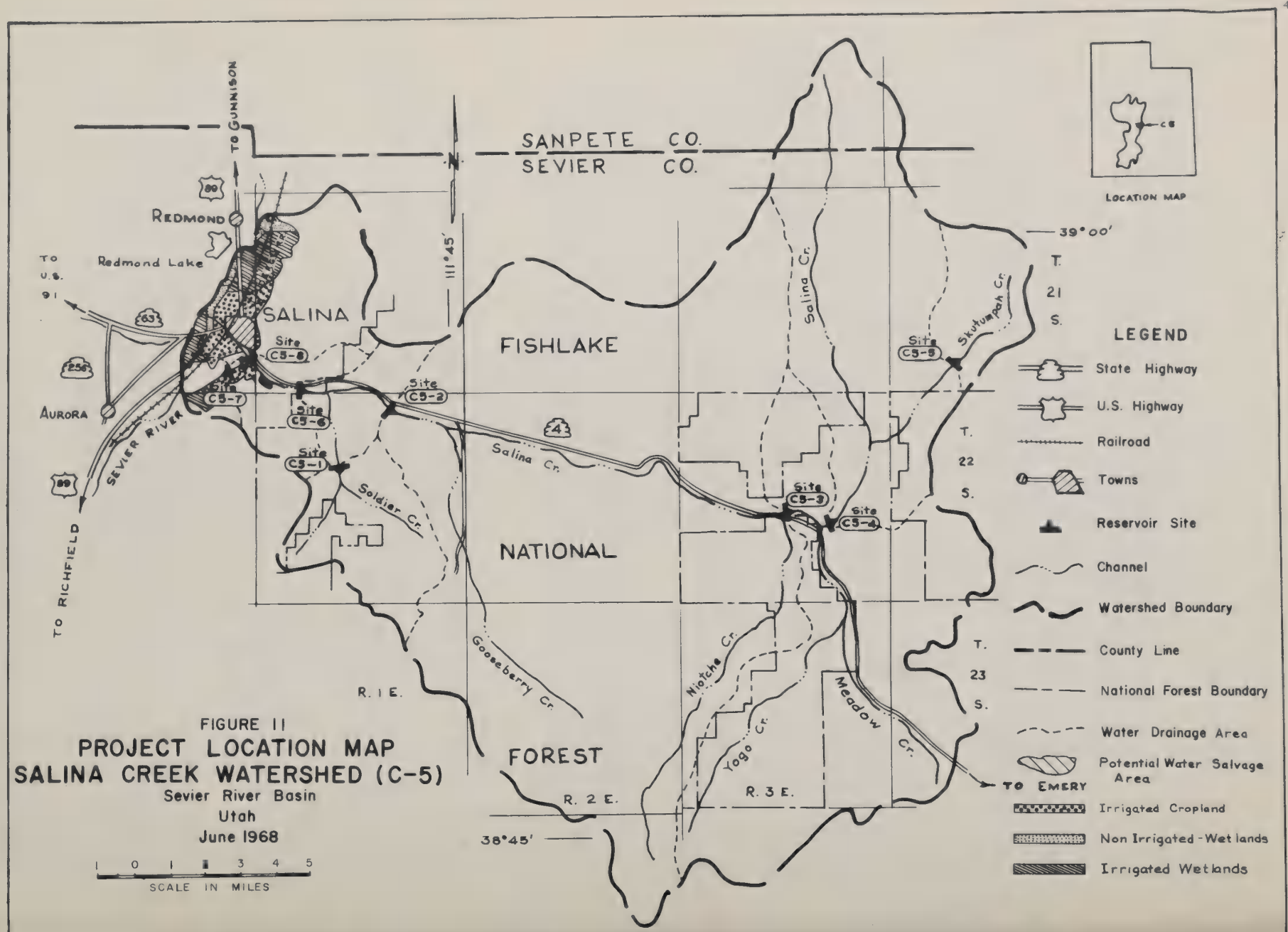


FIGURE 11

PROJECT LOCATION MAP
SALINA CREEK WATERSHED (C-5)

Sevier River Basin
Utah
June 1968

WATERSHED PROBLEMS AND NEEDS

FLOOD PREVENTION

Direct floodwater damages from Salina Creek are $1,650 per year. Damages are primarily from convective storms producing floods which destroy and impair irrigation structures, flood farm land, and damage other improved areas. Approximately 60 percent of the recorded floods occurred in the month of August.

EROSION AND SEDIMENT

Erosion is a serious problem on many areas where vegetation does not adequately protect the soil, a condition associated with past heavy grazing and areas of geologic erosion. This lessens the productivity of the land and makes it increasingly difficult to restore a good vegetation-soil-water hydrologic relationship. Steep slopes and high intensity rainfall add to the problem. There is heavy to excessive erosion on 53,700 acres and 14,000 acres contain geologic erosion which has not been accelerated by man. (Figure 12)

There are areas with annual sediment rates of 0.7 acre-feet per square mile but the average is 0.46 acre-feet per square mile for the total upstream watershed. Streambank erosion also contributes heavily to the sediment yield. The average annual sediment volume carried by Salina Creek is 130 acre-feet. These rates are based on sediment deposition in existing reservoirs and debris basins. Sediment damages occurring to irrigation distribution systems and property located in Salina total $39,890 per year.

LAND TREATMENT

Land treatment on upper watershed lands is necessary to correct unsatisfactory watershed conditions resulting from excessive erosion and unstable soils. Needs for irrigated lands are orientated around water management, sediment deposits, and conveyance problems.

FIGURE 12

EROSION CONDITION MAP SALINA CREEK WATERSHED (C-5)

Sevier River Basin

Utah

June 1968

1 0 1 2 3 4 5

SCALE IN MILES

AGRICULTURAL WATER MANAGEMENT

Resource studies indicate that the water supply for the irrigated area is adequate in normal years. On a frequency basis, the root-zone deficit for water-short periods is 1,100 acre-feet and the average deficit is 220 acre-feet. The water budget for average conditions indicates a 3,700 acre-foot loss to groundwater from excess irrigation and distribution losses.

There is a need for facilities to establish a call-demand system which would provide storage for early snow melt waters. In conjunction with this, agricultural water management training for the farmer would be helpful.

Canal and on-farm ditch lining on the entire distribution system are not economically practical from a water savings standpoint. However, there is a need for land leveling, stream flow regulation, and canal and ditch lining on high-loss sections and to facilitate operation and maintenance work. Redistribution of irrigation companies water stock so that each irrigated acre would have an adequate supply can help increase water-use efficiency.

RECREATION

The Utah State Highway Department has estimated an increase of traffic through Salina Canyon from the present 700 cars per day to 2,200 cars per day upon completion of I-70. Projections to 1980 indicate an area population within a one-hours' driving time of 24,000 people over 12 years old. Data from the Outdoor Recreation Resources Review Commission Study of future availability of various types of recreation indicate the annual demand for fishing, picnicking, and camping will be 27,000 activity days per year.

Construction of project features in Salina Canyon must consider protection of aesthetic values. Camping and picnic sites, sanitation facilities, conservation pools, public access, and shade and rest areas are essential at water storage sites to accommodate recreation use.

P H Y S I C A L P O T E N T I A L F O R M E E T I N G N E E D S

There were eight reservoir sites identified with storage potential. Their physical characteristics are listed in Tables 31 and 38.

TABLE 31.--Structure data - storage capacity, Salina Creek Watershed (C-5), Sevier River Basin

Item	Unit	Site			
		C5-1 Soldier Canyon	C5-4 Bull Pasture	C5-5 Skutumpah	C5-8 Salina
Drainage area	Square miles	14.6	14.2	8.9	292.4
Estimated height of dam	Feet	70	75	45	70
Estimated volume of fill	Cubic yards	157,000	100,000	40,000	675,000
Principal spillway					
Type		R/C Conduit	R/C Conduit	R/C Conduit	R/C Conduit
Release rate	CSM	10	10	10	---
	C.F.S.	---	---	---	1,250
Emergency spillway					
Type		Concrete	Concrete	Concrete	Concrete
Chance of use	Percent	2	2	2	1
Maximum surface area - emergency spillway level	Acres	25	76	54	306
Storage					
Sediment	Acre-feet	680	1,420	450	7,240
Recreation	Acre-feet	---	540	150	---
AWM	Acre-feet	---	---	500	---
Total storage	Acre-feet	680	1,960	1,100	7,240
Additional storage capacity available	Acre-feet	---	4,000	---	1,160
Freeboard storage	Acre-feet	90	---	260	2,000
Surface of recreational pool	Acres	---	76	44	---

Sites C5-2 and C5-6 are limited in size and use due to planned highway development. Sites C5-4, C5-5, and C5-8 have potential for multiple use as recreation and irrigation storage facilities. Campgrounds can be included at these three sites. Site C5-7 is an off-channel site which will require a diversion from Salina Creek. Its potential is limited by foundation conditions.

There are areas where the irrigation distribution canal systems can be effectively lined to reduce seepage losses.

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed receives technical assistance through the Sevier County Soil Conservation District. An application for planning assistance under PL-566 was made in January 1955 by the Sevier County Soil Conservation District, Salina Creek Irrigation Company, and Salina City Corporation. The following desire to co-sponsor or support the project: Skutumpah Irrigation and Reservoir Company, Brown's Hole Graziers Association, Water Hollow Graziers Association, Meadow Gulch Cattle Graziers Association, Salina Creek Cattle Association, Sheep Graziers (Salina Creek sheep permittees), Salina Creek private land owners, Sevier County Board of Commissioners, North Sevier Chamber of Commerce, Salina Junior Chamber of Commerce, Salina Lions Club, and the Sevier County Fish & Game Protective Association.

Recent contact with the sponsors indicates they would like to proceed with the project as soon as planning assistance under PL-566 is available.

Consideration was given to desires of the local people, but was not the basis for project evaluation.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT

Land treatment measures for the upper watershed areas which will be applicable for acceleration under a project are as follows: Pinyon-juniper and sagebrush removal and seeding, furrowing and reseeding,

plow and seed, contour trench and seed, aerial spray, aerial spray-harrow and seed, and gully plugs.

Land treatment needs for the irrigated lands will be primarily land leveling. This is to cope with the buildup of sediment which causes excessive operation and maintenance costs. On-farm ditch lining and other water management practices are also applicable to the irrigated farm lands.

STRUCTURAL MEASURES

Structural measures are for flood and sediment control, irrigation water management, and recreation.

Enlargement of the present Skutumpah Reservoir, Site C5-5, with a capacity of 1,100 acre-feet will restore its 500 acre-foot irrigation storage right, provide 450 acre-feet of sediment storage (100-year containment), and a fishery with a surface area of 44 acres.

Enlargement of the Bull Pasture Reservoir, Site C5-4, to a capacity of 1,960 acre-feet will provide for 100-year sediment containment capacity of 1,420 acre-feet and a recreation pool with 540 acre-feet and 76 surface acres.

Increasing the size of Soldier Canyon debris basin, Site C5-1, will provide 100-year sediment containment capacity of 680 acre-feet.

Site C5-8, Salina, will provide a 7,240 acre-foot sediment pool which can be utilized for recreation developments during its 100-year life. A 140-family unit campground is to be installed in conjunction with the reservoir. Irrigation regulatory storage and a fish and wildlife pool can be operated until the pool fills with sediment.

The flood routing effect of the reservoirs will help reduce flood damages even though no floodwater storage is provided below the emergency spillway elevations. The Site C5-8, Salina, would divert the floodwaters from Salina Creek, above the town of Salina, and directly to the Sevier River.

Identification of specific sites for structures or other impoundment measures at this time does not indicate or imply that these sites will prove either feasible or most desirable at some future time or that, following additional study, other factors may enter in which would prevent their use.

The foundation and seepage conditions of possible reservoir site locations were considered only in generalities. Seepage may be a limiting factor for use of Site Nos. C-5, C5-7 and C5-8 as irrigation storage structures. These sites are located in fault and deep alluvial soil areas.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

RESERVOIRS

Capacities needed at Site C5-4, Bull Pasture, and Site C5-5, Skutumpah, were based on irrigation storage rights, expected sediment, and minimum fish pool requirements. Needed capacities at Site C5-1, Soldier Canyon, and Site C5-8, Salina, were based on estimated sediment volume at this point.

Sediment volumes were estimated from expected effects of land treatment measures and present sedimentation rates. Sedimentation rates were estimated from deposits in existing reservoirs and studies of watershed erosion conditions. (Table 32)

Quantity estimates were obtained by using reconnaissance topographic maps. Costs were based on similar construction costs in the state of Utah. Investigation for Site C5-8 was performed in detail due to its importance to the project and the need for coordination of planning efforts with the Utah Department of Highways.

CAMPGROUNDS

Estimates of installation costs are based on costs for similar developments. The number of units were determined from the projected demand and utilization. (Table 33 and 34)

ENGINEERING SERVICES

Engineering services were estimated at 12.5 percent of construction costs.

TABLE 32.--Sediment control by structures, Salina Creek Watershed (C-5), Sevier River Basin

Site number	Drainage area	100-year sediment yields				Passed from above sites	Total into site	Required sediment pool capacity	Planned storage		
		Without project		With project					Pool	Aerated	Total
		Rate	Amount	Rate	Amount						
	Square miles	Acre-feet/ square mile/year	Acre-feet	Acre-feet/ square mile/year[a]	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet
C5-5	8.9	0.70	623	0.53	502	0	502	452	450	25	475
C5-4	48.4	0.40	1,936	0.30	1,549	25	1,574	1,417	1,420	75	1,495
	78.8[b]	0.50	3,940	0.38	3,184	78	3,262	2,446	---	---	---
	123.9	0.38	4,709	0.30	3,916	3,262	7,178	5,384	---	---	---
C5-1	14.6	0.70	1,022	0.60	905	0	905	679	680	180	860
C5-8	12.8	0.70	893	0.63	822	7,223	8,045	7,240	7,240	400	7,640
Total	---	---	13,123	---	10,878	---	---	---	---	---	10,470

[a]Rate effective 20 years after installation date.

[b]Drainage data for sites excluded. These drainages are above Site C5-8 and below Site C5-4.

TABLE 33.--Estimated structural cost-potential development,[a] Salina Creek Watershed (C-5), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Debris basins	Each	1	245,300
Multiple-purpose structures			
Recreation & AWM	Each	2	1,071,300
Recreation	Each	1	187,500
Campgrounds	Each	3	119,300
Total			1,623,400
Engineering services			202,800
Land easements & rights-of-way plus water rights			356,900
Grand total			2,183,100

[a]Price Base 1967.

TABLE 34--Distribution of structural cost-potential development,[a] Salina Creek Watershed (C-5), Sevier River Basin

Site number	Structure name	Construction	Engineering services	Land easements, water rights & rights-of-way	Installation costs
		Dollars	Dollars	Dollars	Dollars
C5-1	Soldier Canyon	245,300	30,700	100	276,100
C5-4	Bull Pasture	187,500	23,400	33,000	243,900
	Campgrounds	28,500	3,500	100	32,100
C5-5	Skutumpah	75,000	9,400	22,000	106,400
	Campgrounds	7,800	900	100	8,800
C5-8	Salina	996,300	124,500	261,600	1,382,400
	Campgrounds	83,000	10,400	40,000	133,400

[a]Price Base 1967.

EASEMENTS AND RIGHTS-OF-WAY

It is anticipated that easements and rights-of-way on National Forest lands will be furnished at little or no cost to the sponsors. Costs on private lands are based on 1967 prices for purchase of these lands including improvements. Water rights costs are based on amounts lost or used. Rights-of-way for Site C5-8, Salina, includes cost of relocating Highway 4 as a frontage road for Interstate Highway I-70.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs are based on the expected life and repair cost for each structure. The costs for operating campgrounds does not include daily cleanup operations. (Table 35)

COST ALLOCATION

The use of facilities method was used to allocate costs for Sites C5-1, Soldier Canyon, C5-4, Bull Pasture, and C5-5, Skutumpah. For Site C5-8, Salina, the alternative justifiable expenditure method was used. (Table 36)

PROJECT ADMINISTRATION

This item was estimated as 13 percent of construction costs.

E F F E C T S A N D E C O N O M I C F E A S I B I L I T Y O F P O T E N T I A L D E V E L O P M E N T

With the level of development described, sediment related damages would be reduced 97 percent after project installation for a 100-year period. The containment of 10,470 acre-feet of sediment in the 4 reservoirs will yield annual benefits of $38,690. Upper watershed land treatment will reduce the sediment problem. A 90-percent reduction in flood damages will occur through effects of land treatment and the routing effects of the reservoirs. Damage reduction benefits from

TABLE 35.--Annual costs,[a] Salina Creek Watershed (C-5), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Reservoirs and developments			
C5-1 Soldier Canyon	9,360	1,380	10,740
C5-4 Bull Pasture	8,270	1,000	9,270
Campgrounds	1,090	2,500	3,590
Total	9,360	3,500	12,860
C5-5 Skutumpah	3,600	530	4,130
Campgrounds	300	1,150	1,450
Total	3,900	1,680	5,580
C5-8 Salina	46,900	5,000	51,900
Campgrounds	4,520	4,500	9,020
Total	51,420	9,500	60,920
Project administration	---	---	7,200
Grand total	---	---	97,300

[a]Price Base: Installation 1967. O&M 1967.

[b]100 years @ 3¼ percent interest.

TABLE 36.--Cost allocation and cost sharing summary,[a] Salina Creek Watershed (C-5), Sevier River Basin

Item	Cost allocation				Cost sharing							
	Purpose				Federal				Nonfederal			
	Flood & sediment	Recreation	A.W.M.	Total	Flood & sediment	Recreation	A.W.M.	Total	Flood & sediment	Recreation	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
C5-1 Soldier Canyon	276,100	---	---	276,100	276,000	---	---	276,000	100	---	---	100
C5-4 Bull Pasture	159,200	84,700	---	243,900	159,200	25,900	---	185,100	---	58,800	---	58,800
Campground	---	32,100	---	32,100	---	17,800	---	17,800	---	14,300	---	14,300
C5-5 Skutumpah	34,500	22,500	49,400	106,400	34,600	6,600	21,100	62,300	---	16,200	27,900	44,100
Campground	---	8,800	---	8,800	---	4,800	---	4,800	---	4,000	---	4,000
C5-8 Salina	1,357,400	10,000	15,000	1,382,400	1,095,800	5,500	8,000	1,109,300	261,600	4,500	7,000	273,100
Campground	---	133,400	---	133,400	---	51,900	---	51,900	---	81,500	---	81,500
Grand total	1,827,200	291,500	64,400	2,183,100	1,565,600	112,500	29,100	1,707,200	261,600	179,300	34,900	475,900

[a]Price Base 1967.

direct flooding is $1,480 per year. Local secondary benefits of $6,020 are from sediment and flood control combined. On-farm land treatment will help to overcome the effects of past sedimentation. (Table 37)

To eliminate the average annual irrigation deficit of 220 acre-feet root-zone water, storage and regulation in Site C5-5, Skutumpah, and Site C5-8, Salina, will be provided. The average annual benefit for reducing deficits is $3,870. Local secondary benefits for agricultural water management measures are $580.

Fishing facilities will be provided in Site C5-4, Bull Pasture, Site C5-5, Skutumpah, and Site C5-8, Salina. Estimated use and storage capacities will result in annual fishing benefits of $21,870. Local secondary benefits represent $2,800 of these annual benefits.

Campground facilities and other water based activities associated with Sites B5-4, Bull Pasture, C5-5, Skutumpah, and C5-8, Salina, are expected to provide an average annual benefit of $23,300. Demand was based principally on population projections and competition from other facilities. Local secondary benefits represent $3,090 of the total annual.

The maximum average downstream effect expected at the level of development described is a reduction in annual flow of 950 acre-feet. Much of this would probably be absorbed by a reduction in use by the wetlands near Salina. The principal increase in use would be evaporation from the reservoir surfaces.

The annual associated land treatment benefits are $4,030.

Redevelopment benefits occur from construction and operations and maintenance by providing an opportunity to use goods, services and labor from a locality designated an economic distress area under the Area Redevelopment Act. For this project the average annual redevelopment benefits are $20,060.

Total local secondary benefits are $12,510.

The ratio of average annual benefits to average annual costs for all works of improvement, including primary and local secondary benefits would be 1.2:1. The benefit cost ratio excluding local secondary benefits would be 1.1:1.

TABLE 37.--Comparison of benefits and costs for structural measures,[a] Salina Creek Watershed (C-5), Sevier River Basin

Evaluation units	Average annual benefits						Total annual benefits	Average annual cost[b]	Benefit cost ratio
	Direct flood damage	Sediment damage	Recreation	A.W.M.	Redevelopment	Secondary			
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	
C5-1 Soldier Canyon	100	2,710	---	---	2,720	420	5,950	10,740	0.6:1
C5-4 Bull Pasture	210	5,420	4,560	---	2,090	1,530	13,805	9,270	1.5:1
Campgrounds	---	---	4,780	---	810	720	6,310	3,590	1.8:1
Total	210	5,420	9,340	---	2,900	2,250	20,120	12,860	1.6:1
C5-5 Skutumpah	70	1,940	2,640	3,210	840	1,180	9,880	4,130	2.4:1
Campgrounds	---	---	1,190	---	300	180	1,670	1,450	1.2:1
Total	70	1,940	3,830	3,210	1,140	1,360	11,550	5,580	2.1:1
C5-8 Salina	1,100	28,630	11,820	660	10,980	6,330	59,520	51,900	1.1:1
Campgrounds	---	---	14,340	---	2,310	2,150	18,800	9,020	2.1:1
Total	1,100	28,630	26,160	660	13,290	8,480	78,320	60,920	1.3:1
Project administration	---	---	---	---	---	---	---	7,200	---
Grand total	1,480	38,700	39,330	3,870	20,050	12,510	115,940	97,300	1.2:1

[a]Price Base 1967.

[b]From Table 35.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Importation of water and construction of Interstate Highway I-70 will play important roles in the formulation of a PL-566 project.

The importation of water will provide additional water for the irrigated lands. This will afford an opportunity for extensive distribution system improvements, better allocation of rights, and storage for additional recreation waters. With this additional development, Site C5-4, Bull Pasture, could be enlarged to hold approximately 5,000 acre-feet of irrigation water. This site could benefit irrigated lands at approximately $25,000 a year for a total cost of $425,000 (1.5:1 benefit cost ratio).

The construction of I-70 will provide the opportunity for stabilizing stream channels and reducing their sediment yields. The exact routing of the highway may affect the location or capacities of some of the reservoirs included in the project.

Agricultural water management training and irrigation system improvements are not eliminated as possible features of a project. Table 38 and 39 list some additional reservoir alternatives for possible inclusion in a project.

TABLE 38.--Additional reservoir data of additional sites investigated, Salina Creek Watershed (C-5), Sevier River Basin

Item	Unit	Site			
		C5-2 Rattlesnake Point	C5-3 Taylor's Flat	C5-6 Blackberry	C5-7 Tipparary
Drainage area	Square miles	124.6	94.2	---	---
Estimated height of dam	Feet	65	30	120	---
Estimated volume of fill	Cubic yards	165,000	---	1,041,000	---
Principal spillway					
Type		R/C Conduit	R/C Conduit	R/C Conduit	R/C Conduit
Release rate	CSM	10	10	10	---
Emergency spillway					
Type		Concrete	Concrete	Concrete	Concrete
Chance of use	Percent	2	2	2	2
Maximum surface area - emergency spillway level	Acres	55	14	---	---
Storage					
Sediment	Acre-feet	1,090	250	6,000	---
Recreation	Acre-feet	---	---	1,230	---
Total storage	Acre-feet	1,090	250	7,230	1,300
Additional storage capacity available	Acre-feet	1,000[a]	---	---	---

[a]Requires coordination with Interstate I-70 Highway development.

TABLE 39.--Alternate control by structures, Salina Creek Watershed (C-5), Sevier River Basin

Site number	Drainage area	100-year sediment yields				Passed from above sites	Total into site	Required sediment pool capacity	Alternate plan sediment storage
		Without project		With project					
		Rate	Amount	Rate	Amount				
	Square miles	Acre-feet/ square mile/year	Acre-feet/ 100 years	Acre-feet/ square mile/year[a]	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet
C5-5	8.9	0.70	623	0.53	502	---	502	452	475
C5-4	48.4 78.8	0.40 0.50	1,936 3,940	0.30 0.38	1,549 3,184	25 78	1,574 3,262	1,417 ---	1,420 ---
C5-2	123.9	0.38	4,709	0.30	3,916	3,262	7,178	5,384	1,450
C5-1	14.6	0.70	1,022	0.60	905	---	905	679	860
C5-8	12.8	0.70	893	0.63	822	5,844	6,666	5,999	6,330
Total	---	---	13,123	---	10,878	---	---	---	10,535

[a]Rate effective 20 years after installation date.

RICHFIELD WATERSHED (D-1)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
SEVIER COUNTY, UTAH
June 1968

THE WATERSHED IN BRIEF

The watershed is located in Sevier County, Utah, contains 135,600 acres, and comprises 2.6 percent of the Sevier River Basin. The ownership of these lands are private, 36,740 acres; state, 2,680 acres; Federal lands administered by the Bureau of Land Management, 30,596 acres; and National Forest, 65,584 acres. The principal city is Richfield with a population of 4,412 (1960 census). The population trend for this central Utah community is on the increase. Other communities include Joseph, Elsinore, and Aurora with resident populations of 117, 483, and 465, respectively (1960 census). The total area population is estimated at 5,758. (Figure 13)

Crops are produced on 19,880 acres of irrigated rotation croplands of which 59 percent is alfalfa and improved pasture, 27 percent small grains, 8 percent corn, and 6 percent sugar beets.

The average annual precipitation varies from 8 to 25 inches depending on elevation. Average precipitation on irrigated croplands is 10 inches. Elevations for the watershed range from 10,279 to 5,250 feet.

The major water supply for irrigated lands is diverted from the Sevier River through the Sevier Valley Canal. Several smaller canals, Joseph, Elsinore, Richfield, and Vermillion, also divert water from the Sevier River and deliver irrigation water to smaller blocks of irrigated land. The tributary yield from the upper watershed is 14,800 acre-feet per year, primarily from North and South Cedar Ridge, Willow Creek, and Cottonwood Canyons along the west front of the Pavant Range. Most of this water is diverted to small tracts of irrigated land on the alluvial fans.

The watershed includes Mountain range sites with Cryoboroll soils, 20 percent; Upland range sites with Argixeroll, Calcixeroll and Haploxeroll soils, 35 percent; Semidesert range sites with Torrifluvent and Calciorthid soils, 35 percent; and Wetland soils that are Haplaquepts, 10 percent. The vegetation of the upper watershed is varied with portions of aspen, conifer, pinyon-juniper, oakbrush, and sagebrush. (Figure 14)

The watershed is bounded on the west by the Pavant Range with elevations over 10,000 feet and the Sevier River on the east.

FIGURE 13

PROJECT LOCATION MAP
RICHFIELD WATERSHED (D-1)

Sevier River Basin

Utah

June 1968

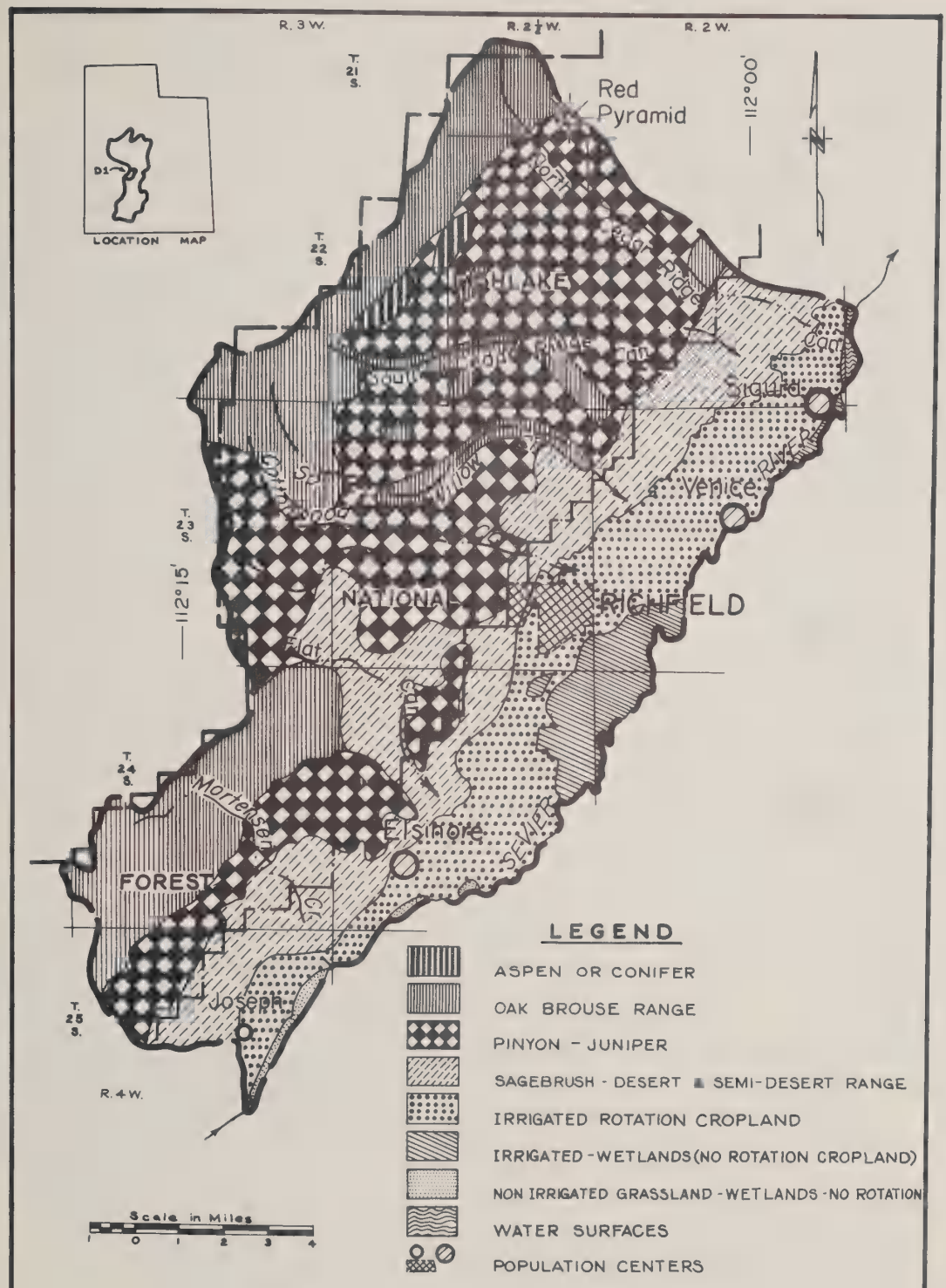


FIGURE 14
LAND USE MAP
RICHFIELD WATERSHED (D-1)
Sevier River Basin
Utah
June 1968

Geologically, Sevier Valley is a graben block bordered on the west by the Elsinore fault and on the east by the Sevier fault. The eastern and western flanks of the valley show evidences of Tertiary volcanic activity. The valley floor is covered with Quaternary alluviums at depths of over 800 feet.

The Pavant Range is a transition between the Basin and Range Province and Colorado Plateau Province and is composed of sediments representative of all geologic eras. Sedimentary and volcanic formations of the Tertiary period are well exposed on the surface. The Colorado Plateaus to the east are composed of flat lying strata with few disconformities and are capped with Tertiary extrusive rocks.

The Laramide orogeny has been the major contributor to the relief of this area with minor relief features of a nontectonic nature.

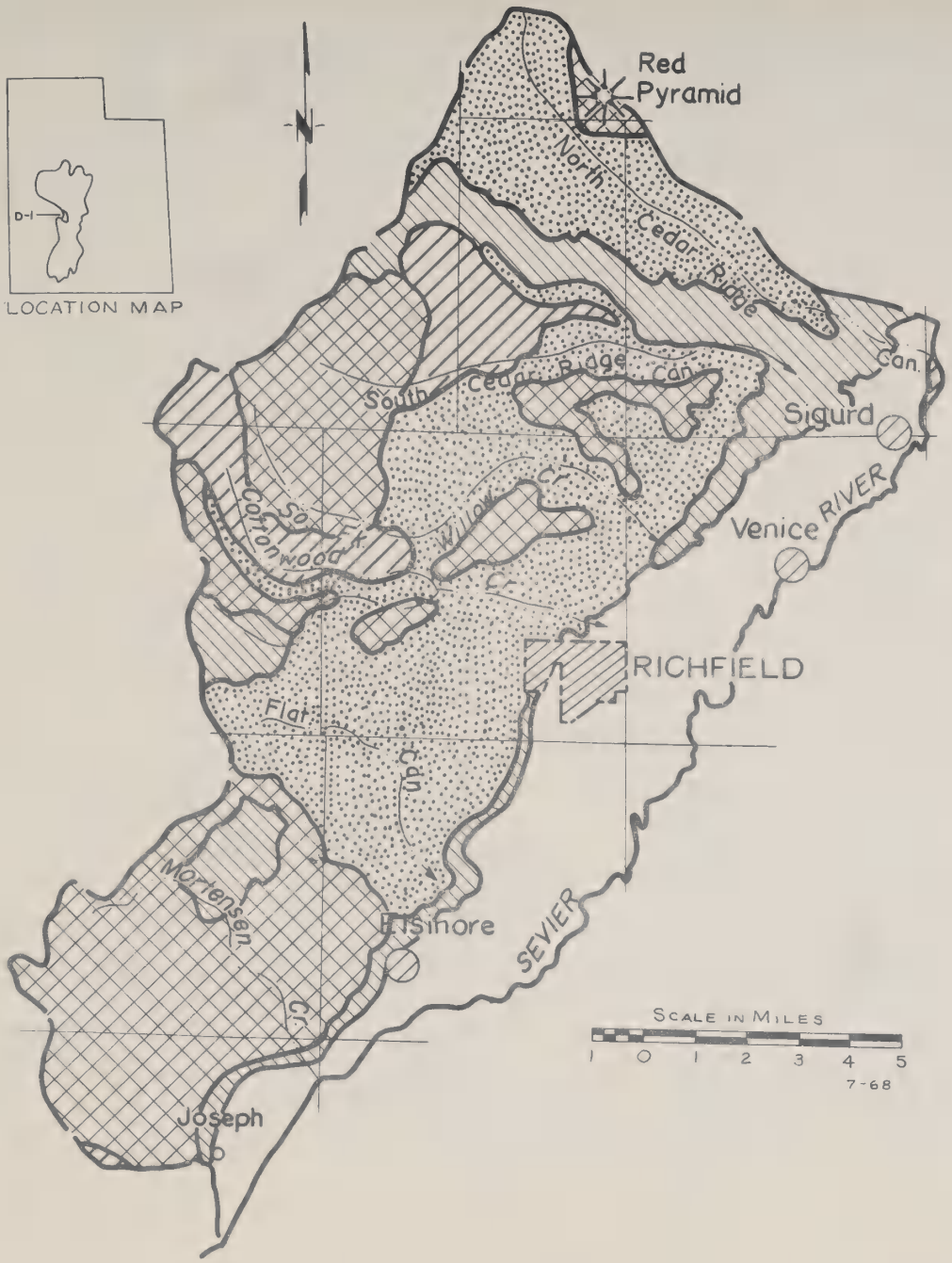
W A T E R S H E D P R O B L E M S A N D N E E D S

EROSION

Heavy grazing and long-term changing climatic conditions have reduced the vegetation in some upper watershed areas and along with adverse geologic conditions, have created serious erosion problems. This has decreased the productivity of the land and made it difficult to restore a good vegetation-soil-water hydrologic relationship. Steep slopes and high intensity rainfall adds to the problem. There is heavy to excessive erosion on 33,900 acres and geologic erosion on 46,100 acres. Streambank erosion contributes excessively to the sediment problem. (Figure 15)

FLOOD AND SEDIMENT REDUCTION

Flat Canyon, Cottonwood Creek, and Willow Creek are major flood source areas that cause serious damages to irrigated crops, water distribution systems, roads and highways, railroads, residences, and businesses. Average annual flood damages are summarized on the following page.



LEGEND

- INCIPIENT EROSION
- LIGHT TO MODERATE EROSION
- HEAVY TO EXCESSIVE EROSION
- GEOLOGICAL EROSION
- UNCLASSIFIED

FIGURE 15

EROSION CONDITION MAP RICHFIELD WATERSHED (D-1)

Sevier River Basin
Utah
June 1968

Flat Canyon

Elsinore Irrigation Company	$250
Richfield Irrigation Canal Company	320
Direct crop and farm damage	7,000
Sevier Valley Canal Company	1,000
Piute Reservoir and Irrigation Company	500
State Highway US-89	1,070
D&RGW Railroad	500
County roads	400
Interruption to irrigation	4,490
Total	$15,530

Cottonwood Creek

Richfield Irrigation Canal Company	$430
Sevier Valley Canal Company	800
Richfield Cottonwood	740
Piute Reservoir and Irrigation Company	500
Richfield City, residential, and businesses	2,500
State Highway US-89 and U-119	1,720
D&RGW Railroad	1,000
County roads	300
Direct crop and farm damage	3,500
Interruption to irrigation	2,840
Total	$14,330

Willow Creek

Richfield Irrigation Canal Company	$250
Willow Creek Irrigation Company	260
Sevier Valley Canal Company	370
Piute Reservoir and Irrigation Company	400
State Highway US-89	1,070
D&RGW Railroad	500
County roads	300
Direct crop and farm damage	2,000
Interruption to irrigation	2,440
Total	$7,590

LAND TREATMENT

Land treatment on upper watershed lands is needed to correct unsatisfactory conditions resulting from excessive erosion and unstable soils. This would reduce sediment yields and lower flood peaks.

Irrigated land treatment needs are associated with water management. The natural topography coupled with sediment accumulation distributed through the irrigation system requires land leveling periodically in order to achieve reasonable on-farm irrigation application efficiencies.

AGRICULTURAL WATER MANAGEMENT

Several irrigation canal systems distribute irrigation water within the watershed. Water demands fluctuate during the season so laterals and small canals are frequently dry. A time lapse occurs when water is called for and an excessive amount of irrigation water is lost filling the canal and lateral soil profile. There is an average annual water deficit of 4,200 acre-feet.

A need exists to consolidate several canals and laterals. Labor and distribution facilities which duplicate services could be reorganized to avoid unnecessary expenses. Water distribution facilities need to be redesigned to serve the needs of the entire irrigated area. Major canals now traverse sections of communities, and canal consolidation would also reduce the drowning hazard.

P H Y S I C A L P O T E N T I A L F O R M E E T I N G N E E D S

There are a number of potential sites for small reservoirs less than 200 acre-feet. In Flat Canyon, the potential is limited by geologic factors. Here, seepage conditions limit the sites to flood and sediment control. Two sites, D1-1a, Flat Canyon, and D1-5, Cottonwood, have potential for flood detention and can control floods from these canyons.

The physical capabilities of sites investigated are listed in Table 40.

TABLE 40.--Physical capabilities of sites investigated, Sevier River Basin

Reservoir site	Drainage name	Drainage area	Potential storage	Cu. yd./ ac. ft.[a]
		Square miles	Acre-feet	
D1-1a	Flat Canyon	15.8	1,700	240
D1-2	Flat Canyon	14.7	100	200
D1-3	Flat Canyon	11.1	140	280
D1-4	Cottonwood Creek	1.7	3,000	170
D1-4b	Cottonwood Creek	8.5	1,200	280
D1-5	Cottonwood Creek	19.8	1,800	190
D1-12	Cottonwood Creek	1.6	1,200	210
D1-15	Willow Creek	18.1	1,000	200

[a]Cubic yards of earth fill per acre-foot of reservoir storage.

In Cottonwood and Willow Creek drainages, there were seven reservoirs investigated that have potential for multipurpose storage. Structure Site D1-1 is limited by geologic conditions.

Groundwater reserves are available for additional irrigation water supplies. Approximately 50 wells yielding 3 c.f.s. per well could be developed. However, water rights limit use of this source at present.

It is physically feasible to effectively line the major portion of existing irrigation distribution canals.

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed receives technical assistance through the Sevier County Soil Conservation District.

Principal flood sources, Flat Canyon, Cottonwood Creek, and Willow Creek, have flooded several times in recent years. Sediment and debris has been deposited in canals, homes and businesses, as well as on highways, roads, and fields. The regularity and severity of flood damage has developed concern among residents to investigate watershed conditions to determine if land treatment and project measures could control these floodwaters. A watershed committee has been established with authority to investigate and prepare a PL-566 application for project planning assistance. Efforts have been to identify project needs and associated benefits.

Cooperation between irrigation companies, the most likely project sponsors, is good. City council representatives are generally in favor of flood control measures and overall resource improvement. Irrigation company officials have expressed interest in studying the advantages of consolidating irrigation companies and canals. Improvements could be accomplished through a new organization.

W O R K S O F I M P R O V E M E N T F O R P O T E N T I A L D E V E L O P M E N T

LAND TREATMENT

Land treatment measures for the upper watershed areas which can be accelerated under a project are: Pinyon-juniper removal and grass reseeding, sagebrush removal and grass reseeding, furrow and grass reseeding, plow and grass seeding, contour trench and grass seeding, aerial spray, aerial spray-harrow and seeding, and gully plugs.

Land treatment needs for the irrigated lands is primarily land leveling. This is to cope with sediment buildup which causes excessive machinery operations and maintenance costs. Ditch lining and other water management practices are also applicable to the irrigated farm lands.

FLOOD PREVENTION

In order to control the floods from Flat Canyon and Cottonwood Creek, two structures have been included as project features. These are Site D1-1a, Flat Canyon, and Site D1-5, Cottonwood. Both sites are Class "C" structures and will provide 100-year flood protection. Irrigation outlet works will be provided to service present water rights of each drainage. (Table 41)

TABLE 41.--Structure data - storage capacity, Richfield Watershed (D-1), Sevier River Basin

Item	Unit	Site D1-1a Flat Canyon	Site D1-5 Cottonwood
Class of structure		"C"	"C"
Drainage area	Square miles	15.8	19.8
Estimated height of dam	Feet	25	75
Estimated volume of fill	Cubic yards	400,000	335,000
Principal spillway			
Type		R/C Conduit	R/C Conduit
Release rate	CSM	10	10
Emergency spillway			
Type		Earth	Earth
Chance of use	Percent	1	1
Maximum surface area - emergency spillway level	Acres	55	40
Storage			
Sediment, submerged	Acre-feet	1,100	1,200
Sediment, areated	Acre-feet	350	460
Detention	Acre-feet	600	600
Total storage	Acre-feet	1,700	1,800
Additional storage capacity available	Acre-feet	500+	500+

Identification of specific sites or structures on National Forest lands at this time does not indicate or imply that it would prove either feasible or most desirable at some future time.

AGRICULTURAL WATER MANAGEMENT

Lining for 72 miles of canal and main laterals has been included. This includes consolidating distribution systems into one main canal system. This will require abandoning Elsinore, Joseph, Richfield, and Vermillion canals and combining them with the Sevier Valley canal which will follow its present alignment. This consolidation will service the lands of the old companies by installing laterals from the new main canal.

The main canal will be lined for approximately 30 miles and is designed to carry 560 c.f.s. at the upper end with stepped reductions to 150 c.f.s. at the lower end. Thirty laterals will be evenly placed to service the irrigated lands below with each designed to carry about 17 c.f.s.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

STRUCTURE DEVELOPMENTS

Construction costs for normal conditions were applied and were based on similar developments in Utah. A 25-percent contingency was applied to dam construction costs and a 20-percent contingency was used with canal lining costs. (Table 42 and 43)

The size of canals were based on peak requirements by reach of canals. For the main canal, the design monthly (July) consumptive-use peak was 5.5 inches. The laterals were designed on a basis of 0.25-inch daily consumptive-use requirement.

ENGINEERING SERVICES

The engineering services costs were 12.5 percent of the construction costs.

TABLE 42.--Estimated structural cost-potential development,[a] Richfield Watershed (D-1), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Canal lining	Miles	72	1,920,000
Flood retarding structures	Each	2	1,378,000
Total			3,298,000
Engineering services			412,300
Land easements & rights-of-way			70,000
Grand total			3,780,300

[a]Price Base 1967.

TABLE 43 .--Distribution of structural cost-potential development,[a] Richfield Watershed (D-1), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Canal lining	1,920,000	240,000	50,000	2,210,000
Reservoirs				
Site D1-1a, Flat Canyon	750,000	93,800	10,000	853,800
Site D1-5, Cottonwood	628,000	78,500	10,000	716,500

[a]Price Base 1967.

EASEMENTS AND RIGHTS-OF-WAY

This item was estimated as a lump sum for incidental costs involved in installation. For structural measures, costs of downstream flow right changes were included in the rights-of-way. There will be legal costs involved in consolidating irrigation systems into one system. These legal cost estimates were included.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs were based on the expected life and repair costs for each item. (Table 44)

COST ALLOCATION

The use of facilities method was used to allocate costs of structural facilities. (Table 45)

PROJECT ADMINISTRATION

This cost was estimated as 13 percent of construction costs.

E F F E C T S A N D E C O N O M I C F E A S I B I L I T Y O F P O T E N T I A L D E V E L O P M E N T

Canal consolidation is planned as a project measure to reduce current water shortages. Increased water available for potential crop use is estimated at 7,500 acre-feet annually.

The water budget analysis indicated an average annual root-zone water deficit of 4,200 acre-feet. This amount was used to determine benefits from lining. Direct annual benefits in water savings total $153,720. Secondary benefits are $23,060. Total annual benefits from canal lining and consolidation are $176,780. Average annual costs are estimated at $133,000. The benefit cost ratio is 1.3:1. (Table 46)

TABLE 44 .--Annual costs,[a] Richfield Watershed (D-1), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Canal lining	75,000	58,000	133,000
Reservoirs			
Site D1-1a, Flat Canyon	28,900	3,800	32,700
Site D1-5, Cottonwood	24,200	3,000	27,200
Project administration	---	---	14,500
Grand total	---	---	207,400

[a]Price Base 1967.

[b]100 years @ 3¼ percent interest.

TABLE 45.--Cost allocation and cost sharing summary,[a] Richfield Watershed (D-1), Sevier River Basin

Item	Cost allocation			Cost sharing					
	Purpose			Federal			Nonfederal		
	Flood Prevention	A.W.M.	Total	Flood Prevention	A.W.M.	Total	Flood Prevention	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Canal lining	---	2,210,000	2,210,000	---	1,200,000	1,200,000	---	1,010,000	1,010,000
Reservoirs									
Site D1-1a, Flat Canyon	853,800	---	853,800	843,800		843,800	10,000	---	10,000
Site D1-5, Cottonwood	716,500		716,500	706,500	---	706,500	10,000	---	10,000
Grand total	1,570,300	2,210,000	3,780,300	1,550,300	1,200,000	2,750,300	20,000	1,010,000	1,030,000

[a]Price Base 1967.

Future construction of Interstate I-70 is planned west of Richfield. Flood retarding structures installed on Flat Canyon and Cottonwood drainages can save the State Highway Department considerable construction funds by reducing peak flood flows from 5,000 and 7,000 c.f.s. (100-year storm) to approximately 150 c.f.s. controlled flow. Interstate I-70 annual maintenance costs without the debris basin structures for Flat Canyon and Cottonwood Creek would range between $3,000 and $7,000 each. These were not included in the annual damage reduction benefit.

Highway construction cost savings were estimated at $350,000 for Flat Canyon and $300,000 for Cottonwood Creek. These estimates were adjusted to an annual basis for 100 years at 3¼ percent interest rate. Annual flood damage reduction benefits accruing to the Flat Canyon debris basin total $15,530. Annual savings to the State Highway Department total $10,160. Annual indirect benefits are estimated to be $2,570. Secondary benefits from this flood protection total $3,850. Total benefits will be $32,110. The average annual cost is estimated to be $32,700. The benefit cost ratio is 1.0:1.

The direct flood reduction benefits from the Cottonwood Creek debris basin total $14,330. The benefits accruing from reduced highway construction costs amount to $10,160. Annual indirect benefits are estimated to be $4,900. Secondary benefits are estimated to be $3,670. Total benefits stemming from the Cottonwood debris basin amount to $33,060. The average annual cost would be $27,200. The benefit cost ratio is 1.2:1.

The total benefits stemming from all project measures including direct and secondary benefits are $241,950. Total average annual costs for all project measures is equal to $207,400. The benefit cost ratio for all project measures is 1.2:1. The total annual benefits stemming from all project measures excluding local secondary benefits are $211,370. Total annual costs for these project measures are $207,400. The benefit cost ratio excluding local secondary benefits is 1.0:1.

Redevelopment benefits were not evaluated as a part of project benefits.

TABLE 46.--Comparison of benefits and costs,[a] Richfield Watershed (D-1), Sevier River Basin

Evaluation units	Average annual benefits				Total benefits	Average annual cost[b]	Benefit cost ratio
	Flood Prevention	Indirect	A.W.M.	Local Secondary			
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	
Canal lining	---	---	153,720	23,060	176,780	133,000	1.3:1
Reservoirs							
Site D1-1a, Flat Canyon	25,690	2,570	---	3,850	32,110	32,700	1.0:1
Site D1-5, Cottonwood Creek	24,490	4,900	---	3,670	33,060	27,200	1.2:1
Project administration	---	---	---	---	---	14,500	---
Grand total	50,180	7,470	153,720	30,580	241,950	207,400	1.2:1

[a]Price Base 1967.

[b]From Table 44.

GLENWOOD WATERSHED (D-2 & 3)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
SEVIER COUNTY, UTAH
June 1968

THE WATERSHED IN BRIEF

The watershed is located in Sevier County and contains 73,800 acres. This area comprises 1.4 percent of the Sevier River Basin. Land ownership is private, 21,460 acres; state, 2,000 acres; Federal lands administered by the Bureau of Land Management, 37,775 acres; and Fishlake National Forest, 12,565 acres. The watershed had a 1960 census population of 289 people, 277 of them were living in the town of Glenwood. (Figure 16)

Irrigated croplands total 1,590 acres. The cropping pattern consists of alfalfa, 57 percent; small grains, 27 percent; corn, 8 percent; sugar beets, 6 percent; and pasture, 2 percent.

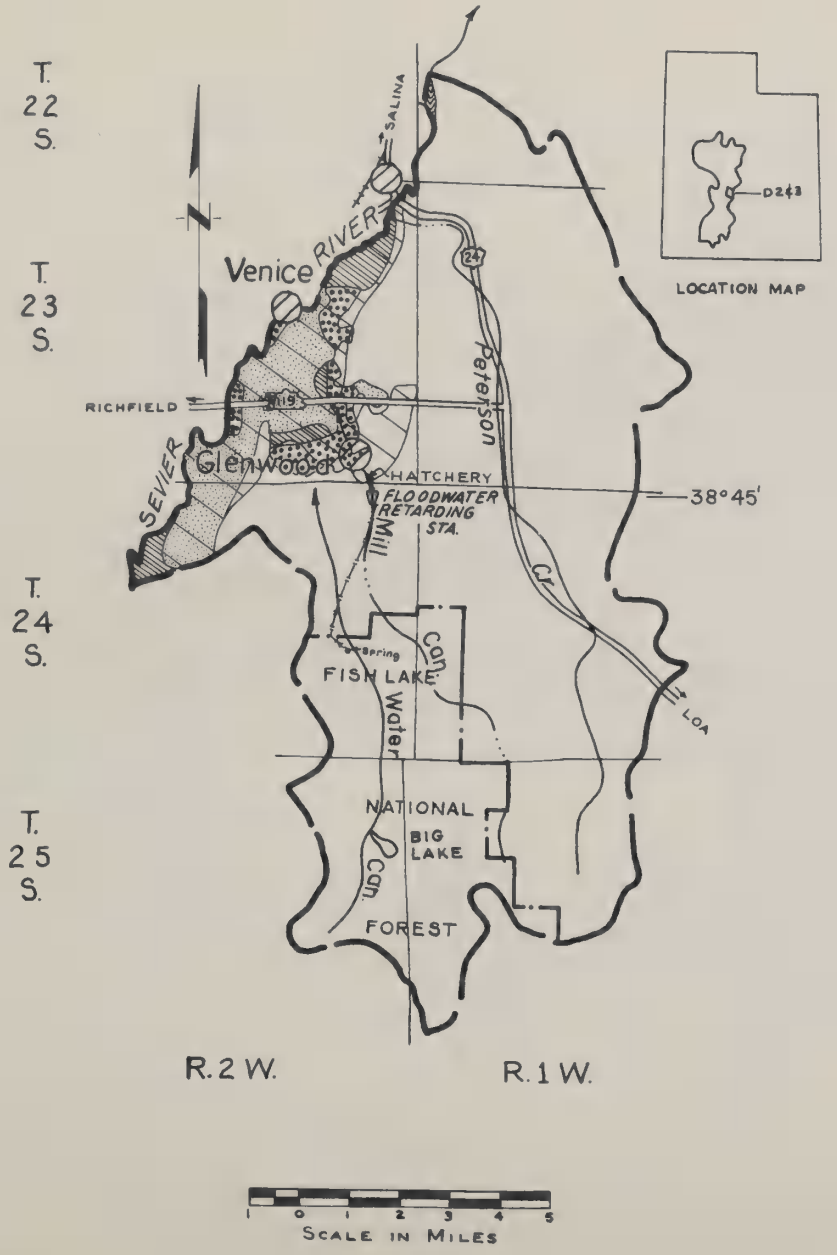
The average annual precipitation varies from 10 to 30 inches depending on elevation with 14 inches average precipitation on the irrigated croplands. The elevations range from 5,263 to 10,600 feet.

The water supply for irrigated lands is obtained from the following sources: Glenwood Springs, Water Canyon, Peterson Canyon, Avery Ditch, Spring Hill Ditch, and two wells, Venice and Wall.

The soils of the watershed are described as follows: High Mountain range sites with Cryoboroll and Cryoboralf soils, 18 percent; Mountain range sites and Cryoboroll soils, 7 percent; Upland range sites with Argixeroll and Calcixeroll soils, 25 percent; Semidesert range sites with Torrifluvent and Calciorthid soils, 30 percent; and Wetlands that are Haplaquepts, 20 percent. The vegetation of the watershed is varied with portions of aspen, conifer, pinyon-juniper, oakbrush, and sagebrush.

The topography consists of a high valley (about 6,000 feet elevation) bordered by the Sevier River on the west and the high Colorado plateaus on the east. Geologically, the Sevier Valley is a graben flanked on the west by the Elsinore fault and on the east by the Sevier fault. The eastern and western edges of the valley show evidences of Tertiary volcanic activity.

The Arapien shales of Jurassic age form complex folds and unconformities on the western flank where the shales overlie younger sediments such as the Tertiary Flagstaff limestone.



LEGEND

- WATERSHED BOUNDARY
- RESERVOIR SITE
- D2&3-X INDEX NUMBER
- CHANNEL
- NATIONAL FOREST BOUNDARY
- POPULATION CENTER
- ROADS, PRIMARY
- RAILROADS
- POTENTIAL WATER SALVAGE AREA
- SPRING
- PIPELINE
- IRRIGATED ROTATION CROPLAND
- IRRIGATED - WETLANDS
- NON IRRIGATED - WETLANDS
- WATER SURFACES

FIGURE 16
PROJECT LOCATION MAP
GLENWOOD WATERSHED (D-2&3)
Sevier River Basin
Utah
June 1968

The high plateaus which comprise the eastern portion of the watershed are composed of flat lying strata capped with Tertiary extrusive rocks that dip gently to the east. The plateaus possess few disconformities of a magnitude beyond local disruptions of strata. The Larimide orogeny has been the major contributor to the relief of this watershed with minor relief features of a nontectonic origin.

W A T E R S H E D P R O B L E M S A N D N E E D S

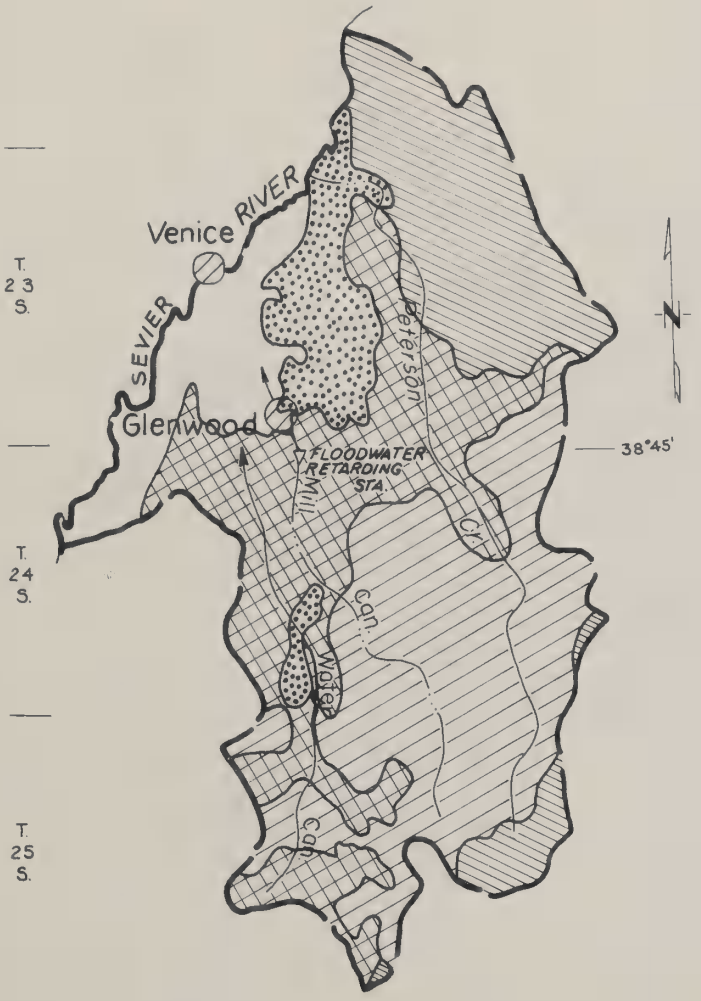
SEDIMENT AND FLOOD DAMAGE

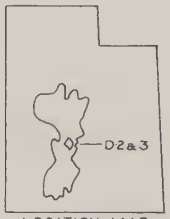
Historically, several damaging floods have occurred within the watershed. Floodwaters from Peterson Creek have washed out the bridge on Highway 24 a number of times as well as blocked traffic on Highway 119. One bridge washed out during a recent flood cost the Highway Department $18,600 to reconstruct.

Farm lands bordering Peterson Creek have been subject to crop damage, land damage, fence damage, and other property damage. Irrigation canals have been filled with sediment, interrupting irrigation water deliveries. Flood sediment and debris cleanout costs for the Venice Pumping Company system has been estimated to be $600 per year. Land treatment and flood control structures are needed to stop erosion and prevent flooding. (Figure 17)

AGRICULTURAL WATER MANAGEMENT

The irrigated lands have an average annual water deficit of 78 acre-feet. Irrigation system improvements such as canal lining and adequate measuring devices are needed to reduce this irrigation water shortage. Water storage facilities are needed to provide adequate late season water as well as enable better irrigation water regulation.





LOCATION MAP

SCALE IN MILES

1 0 1 2 3 4 5

LEGEND

- INCIPIENT EROSION
- LIGHT TO MODERATE EROSION
- HEAVY TO EXCESSIVE EROSION
- GEOLOGICAL EROSION
- UNCLASSIFIED

FIGURE 17

EROSION CONDITION MAP GLENWOOD WATERSHED (D-2&3)

Sevier River Basin

Utah

June 1968

PHYSICAL POTENTIAL FOR MEETING NEEDS

STRUCTURAL MEASURES

The potential for sediment control on Peterson Creek was examined in minimum detail. Debris basin sites are available in quantity and size to contain sediment yields. Actual quantities were not established and only visual inspections were made.

The potential for controlling flood damages to Venice Pump Company and the Venice cemetery are limited due to faults and the Arapien shale formation. However, the possibility of a diversion canal was not evaluated.

Big Lake Reservoir could be enlarged; however, the need for enlargement is limited by potential water yield of its drainage.

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed receives technical assistance through the Sevier County Soil Conservation District. Glenwood residents participated in planning the Mill Canyon-Sage Flat Watershed Protection and Flood Prevention Project in 1955. Since completion in 1959, these people have been relatively free from flood damages. Regular maintenance and repairs have been taken care of by these sponsors and the improvements are in excellent operating condition.

These people have witnessed the benefits stemming from group projects and are vitally interested in other group projects that will enable better utilization of their available water resources. Other residents living in the watershed not directly benefited by the previous watershed project are aware of the benefits and are anxious to participate in other community improvements.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT MEASURES

Land treatment measures for the upper watershed areas include chaining pinyon-juniper, spraying sagebrush, reseeding, and contour terracing. Land treatment needs for the irrigated lands include irrigation water management and conservation cropping systems.

STRUCTURAL MEASURES

Water conveyance losses have been high with the open ditch system. Pipelines originating at mountain springs and major water source areas will practically eliminate conveyance losses.

The installation of a sprinkler irrigation system will greatly facilitate water application to irrigated lands.

Identification of specific sites or structures on National Forest lands at this time does not indicate or imply that it would prove either feasible or most desirable at some future time.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

STRUCTURAL MEASURES

Construction costs for normal conditions based on similar developments in Utah were applied. A 10-percent contingency factor was applied to the cost estimates. The size of the pipelines were determined from expected flows and potential consumptive uses. A peak consumptive-use rate of 0.25 inches per day was used for sprinkler systems design. Costs for sprinkler systems on converted lands were estimated on a cost per acre basis similar to costs on present irrigated lands. (Table 47 and 48)

TABLE 47.--Estimated structural cost-potential development,[a] Glenwood Watershed (D-2 & 3), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Pipelines	Linear feet	77,000	253,300
Total			253,300
Engineering services			30,400
Land easements & rights-of-way			300
Grand total			284,000

[a]Price Base 1967.

TABLE 48 .--Distribution of structural cost-potential development,[a] Glenwood Watershed (D-2 & 3), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Pipelines				
Water Canyon	44,000	5,300	100	49,400
Sprinkler system distribution	156,000	18,700	100	174,800
Sprinkler system distribution (converted lands)	53,300	6,400	100	59,800

[a]Price Base 1967.

ENGINEERING SERVICES

These services were estimated as 12.5 percent of the construction costs.

EASEMENTS AND RIGHTS-OF-WAY

Included in this item is a minimal amount reflecting legal and easement costs.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs were based on the expected life and repair costs for each item. (Table 49)

COST ALLOCATION

The use of facilities method was used to allocate costs of structural facilities. (Table 50)

PROJECT ADMINISTRATION

This cost was estimated as 13 percent of the construction costs.

E F F E C T S A N D E C O N O M I C F E A S I B I L I T Y O F P O T E N T I A L D E V E L O P M E N T

Glenwood and adjacent irrigated lands use the same water distribution system for irrigating lawns, gardens and fields. Project measures include a concrete pipe conveyance system and installation of a sprinkler system for the entire area.

TABLE 49.--Annual costs,[a] Glenwood Watershed (D-2 & 3), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Pipelines			
Water Canyon	1,700	500	2,200
Sprinkler system distribution	5,900	1,900	7,800
Sprinkler system distribution (converted lands)	2,000	600	2,600
Project administration	---	---	1,100
Grand total	---	---	13,700

[a]Price Base 1967.

[b]100 years @ 3¼ percent interest.

TABLE 50.--Cost allocation and cost sharing summary,[a] Glenwood Watershed (D-2 & 3), Sevier River Basin

Item	Cost allocation		Cost sharing			
	Purpose		Federal		Nonfederal	
	A.W.M.	Total	A.W.M.	Total	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Pipelines						
Water Canyon	49,400	49,400	27,300	27,300	22,100	22,100
Sprinkler system distribution	174,800	174,800	96,700	96,700	78,100	78,100
Sprinkler system distribution (converted lands)	59,800	59,800	33,000	33,000	26,800	26,800
Grand total	284,000	284,000	157,000	157,000	127,000	127,000

[a]Price Base 1967.

The installation of a pipeline conveyance system coupled with a sprinkler application system will increase overall irrigation efficiency from 33 percent to 65 percent. The water saved from project measures will be sufficient to eliminate the 78 acre-foot average annual root-zone deficit on 800 acres of presently irrigated lands. The removal of this deficit will produce an estimated annual benefit of $2,810.

Field reorganization is possible with a sprinkler irrigation system. Existing delivery laterals and head ditches use potential cropland that can produce crops with a sprinkler irrigation system. Ownership costs incurred to convert to this system are assumed paid by the increased returns from the additional crop acreage available and by reduced operating costs from more efficient field operation. In addition to the benefits delineated above, project measures will eliminate an estimated $5 per acre canal maintenance and labor requirement. This value applied to 800 acres derives $4,000 annual benefit. Local secondary benefits for this project measure are $1,020. Total annual benefits are $7,830. Average annual cost is $7,800 with a benefit cost ratio of 1:1. (Table 51)

Reduction of canal seepage will facilitate more intensive use of semi-wet meadow. As the water table recedes, these lands will be used as rotated cropland. Benefit estimates are based on 100 acres of alfalfa and 175 acres of improved irrigated pasture.

Water from Water Canyon and springs combined with water from increased efficiency will supply water to these converted acres. Project analysis indicates an average annual benefit of $4,750. Of this amount, $3,000 is allocated to the converted land conveyance system and the remainder to Water Canyon pipeline.

Benefits from converting wet meadows to rotation cropland total $3,000. Secondary benefits are estimated at $450. The benefit cost ratio is 1.3:1.

A pipeline from Water Canyon will carry 2 c.f.s. to the Utah State fish hatchery. This increased diversion will be used for increased fish production and to irrigate the converted wetlands. The portion of the benefit from increased production on converted land attributed to Water Canyon pipeline is $1,750.

The use of water from Water Canyon by the Fish Hatchery has not been evaluated at this level of investigation. An estimate of $1,000 per year benefit to the state is made for purposes of project formulation. Total primary benefits from the Water Canyon pipeline is $2,750. Local secondary benefits are $3,165. Average annual costs are $2,200. Benefit cost ratio for Water Canyon is 1.4:1.

TABLE 51.--Comparison of benefits and costs,[a] Glenwood Watershed (D-2 & 3), Sevier River Basin

Evaluation units	Average annual benefits			Total benefits	Average annual cost[b]	Benefit cost ratio
	Fishery	A.W.M.	Secondary			
	Dollars	Dollars	Dollars	Dollars	Dollars	
Water Canyon pipeline	1,000	1,750	415	3,165	2,200	1.4:1
Sprinkler system distribution (to present lands)	---	6,810	1,020	7,830	7,800	1.0:1
Sprinkler system distribution (converted lands)	---	3,000	450	3,450	2,600	1.3:1
Project administration	---	---	---	---	1,100	---
Grand total	1,000	11,560	1,885	14,445	13,700	1.1:1

[a] Price Base 1967.

[b] From Table 49.

Total annual primary agricultural water management and fishery benefits stemming from pipeline conveyance systems amount to $12,560. Secondary benefits total $1,885 for all pipelines. Direct benefits and secondary benefits combined total $14,445. Total average annual costs for these project measures are $13,700. Benefit cost ratio would be 1.1:1.

Redevelopment benefits and national secondary benefits were not evaluated.

Benefit cost ratio for primary and local secondary benefits is 1.1:1. The benefit cost ratio excluding local secondary benefits is 0.9:1.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Big Lake, south of Glenwood, is presently used to a limited degree for fishing and camping. A potential exists to place a dike through the center and increase the depth and prevent winter kill of fish. There are also sites for camping units. These would not be project measures and were not evaluated.

Flood, sediment, and erosion problems exist on Peterson Creek drainage. Planned land treatment measures will reduce flood damages without PL-566 project measures. Approximately $5,000 annual damages occur on the drainage. Land treatment on the source area and channel are assumed justified at 1:1 benefit cost ratio. No site exists for a large structure to store sediment.

Venice Pump Company receives an estimated $600 per year damage from the drainage east of present system improvements. A potential for a small flood control structure may exist but no cost estimates were made.

Glenwood Cemetery has not received flood damages but is susceptible. No estimates of costs or benefits were made but some flood control work appears feasible.

TROPIC WATERSHED (E-5)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
GARFIELD & KANE COUNTIES, UTAH
August 1968

THE WATERSHED IN BRIEF

The watershed is located in Garfield and Kane Counties and contains 145,700 acres of which 20,520 acres are in Bryce Canyon National Park and 90,170 acres are in Dixie National Forest. It is tributary to the East Fork of the Sevier River and the Paria River and comprises 2.8 percent of the area covered by the Sevier River Basin. The population centers are located at Cannonville and Tropic with 205 and 483 inhabitants, respectively. Total population of the watershed was 750 in 1960 but the population trend has been on the decrease. (Figure 18)

Crop production is from 2,940 acres of irrigated rotation cropland of which 85 percent is alfalfa and deciduous orchards, 5 percent small grain, 5 percent pasture, 2 percent corn (silage), and 3 percent miscellaneous areas.

The annual precipitation ranges from 10.0 to 26.0 inches per year, with an average of 10.4 inches on the croplands. The tributary yield is 23,960 acre-feet annually. This includes 6,750 acre-feet of groundwater outflow to the Colorado River. Elevations range from 5,880 to 10,300 feet. The water supply for irrigated lands comes from the following sources: East Fork of the Sevier River, Tropic Reservoir, Paria River, and Tropic, North, and Henderson Creeks. Tropic Reservoir is a multipurpose structure used for recreation and storage of irrigation water.

The soils are described as follows: High Mountain range sites with Cryoboroll, Cryoboralf, and Cryochrept soils, 15 percent; Mountain range sites, Cryoboroll and Cryochrept soils, 35 percent; Upland range sites and Argiustoll, Calciustoll and Haplustoll soils, 30 percent; and Semidesert range sites, Torrifluvent and Torriorthent soils, 20 percent. The vegetation is varied with portions of aspen, conifer, pinyon, juniper, sagebrush, and oakbrush.

The Tropic watershed topography consists of high plateaus, cliffs, and an amphitheater. The area is drained by two rivers: (1) The East Fork of the Sevier River which drains the Paunsaugunt Plateau and provides internal drainage for the southeastern portion of the Great Basin Province; and (2) the Paria River, tributary to the Colorado River, which drains the area east of the plateau. The Paria River has formed

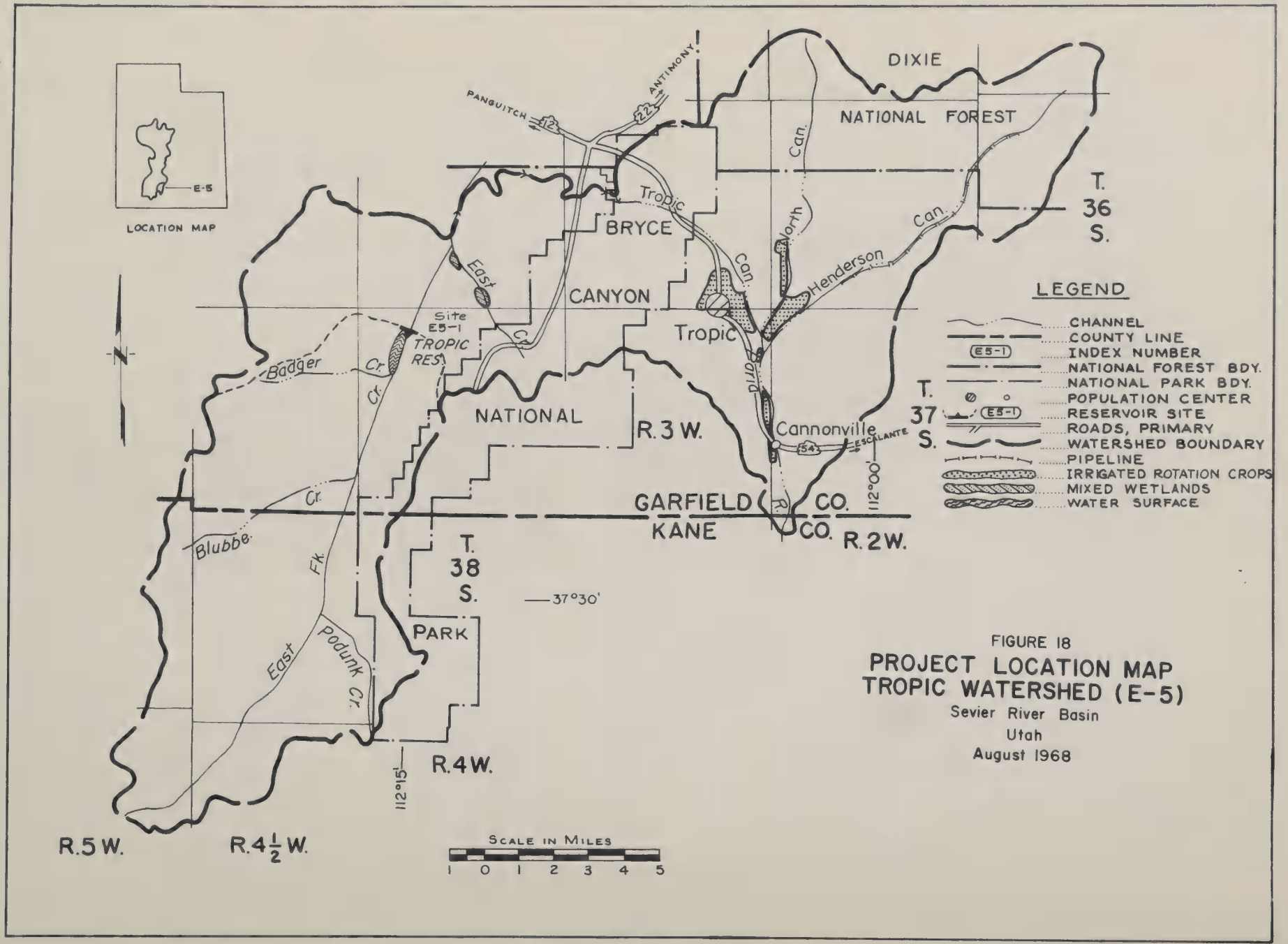


FIGURE 18

PROJECT LOCATION MAP TROPIC WATERSHED (E-5)

Sevier River Basin
Utah
August 1968

an amphitheater where most of the irrigated croplands of the watershed are located.

There are large areas of geologic erosion due to the incompetency of the strata. Bryce Canyon National Park, which exemplifies this erosional feature, is located in the western part of the watershed in predominately the Eocene Wasatch formation. The typical features of badland topography which are evident throughout the watershed include sandy siltstones, shales, lacustrine deposits, systems of vertical conjugate joints, faulting, and weathering due to elevation, water, and frost action. The incompetent strata creates havoc with the irrigation systems by decreasing the water carrying capacities through sedimentation and seepage.

The Laramide orogeny has had little effect on the relief of this portion of the state. The typical geologic structures are simple, consisting mainly of horsts, grabens, monoclines, dikes, sills, and laccoliths. Structures of this nature are of a nontectonic origin. The Paunsaugunt fault traverses the watershed along a north-south axis.

WATERSHED PROBLEMS AND NEEDS

FLOODWATER AND SEDIMENT

Damage from sediment is common throughout the watershed. Much of it is deposited in irrigation systems and on irrigated land. The major problem is found in Water Canyon where sediments from the streambanks are washed into the channel and carried downstream by the water from the transmountain diversion. Channel improvement is needed to arrest this condition. Some sediment is sluiced at the diversion in the mouth of Water Canyon but this is relatively ineffective. The annual water loss through sluicing is 200 acre-feet.

EROSION

Erosion is a serious problem on many areas where vegetation does not adequately protect the soil. This lessens the productivity and makes it increasingly difficult to restore a good vegetation-soil-water hydrologic relationship. Steep slopes and high intensity rainfall add to the problem. There is heavy to excessive erosion on 65,565 acres. About 11,655 acres contain geologic erosion. Streambank erosion also contributes heavily to the sediment yield (Figure 19).

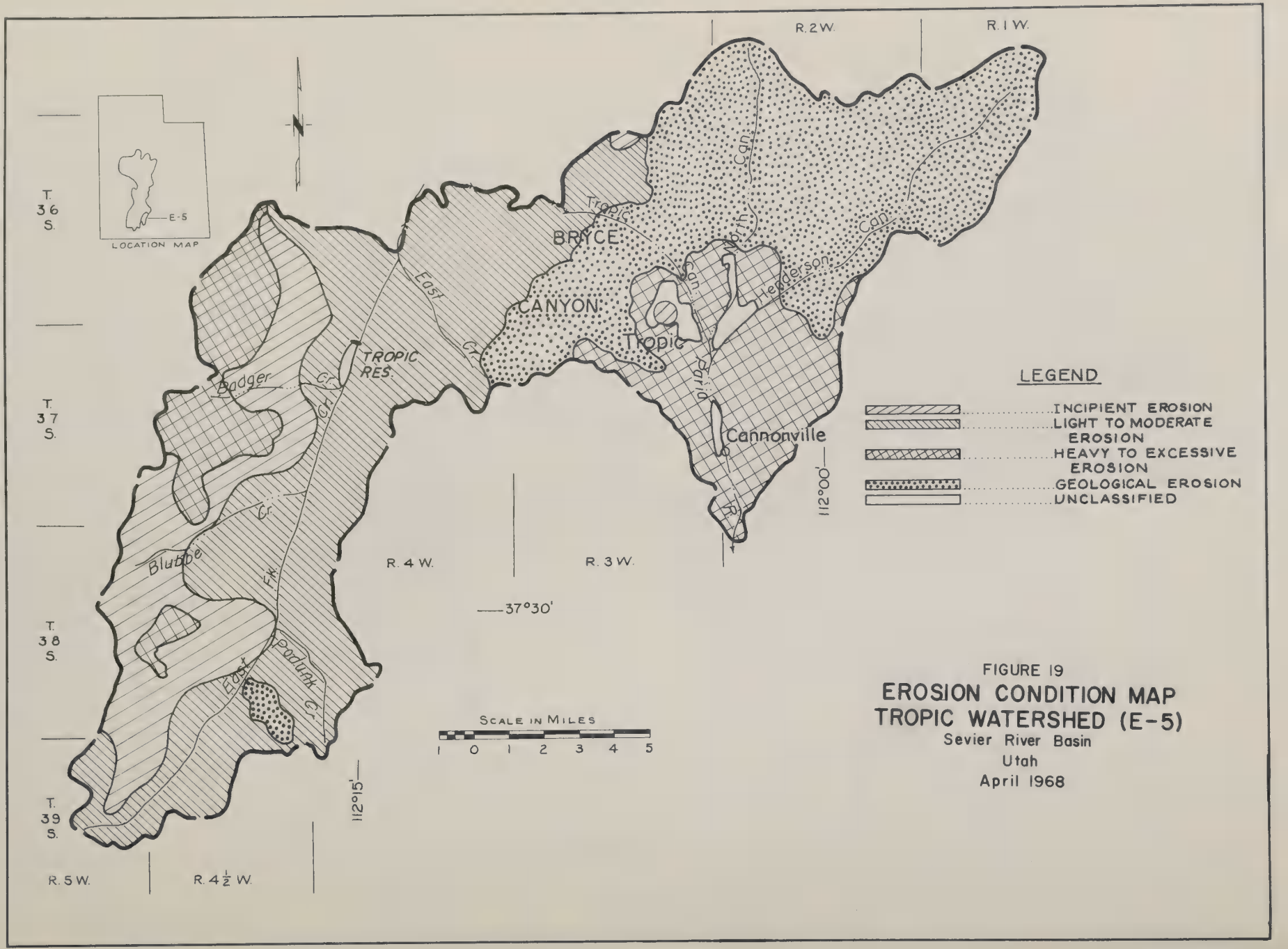


FIGURE 19

EROSION CONDITION MAP TROPIC WATERSHED (E-5)

Sevier River Basin
Utah
April 1968

AGRICULTURAL WATER MANAGEMENT

Water supplies are inadequate. Additional regulation is needed for better seasonal distribution of existing supplies.

Supply-frequency studies show an average annual deficit of 1,570 acre-feet of root-zone moisture with the present 30-percent overall efficiency. A 50-percent efficiency would reduce this deficit to 1,040 acre-feet.

The irrigation distribution systems are in need of improvement. Problems include: (1) Seepage loss from the transmountain diversion canal in the East Fork drainage, (2) sedimentation in the transmountain diversion and canal through Water Canyon, (3) reduced capacity from sedimentation in Tropic Reservoir, (4) scattered and isolated farming areas involving a long canal system in relation to the area served, (5) inadequate water control and measuring devices, (6) seepage losses in the canal systems.

LAND TREATMENT NEEDS

Needed land treatment measures on the East Fork drainage of the watershed have been installed. Additional land treatment is needed for the Henderson and North Canyon drainages. This will help reduce sediment yields and lower flood peaks.

Land treatment needs for irrigated lands are water management oriented. These needs are related to sediment deposits and conveyance problems.

P H Y S I C A L P O T E N T I A L F O R M E E T I N G N E E D S

It will be possible to control the erosion problem in Water Canyon with canal lining or the installation of a pipeline.

Site E5-1, Tropic Reservoir, can be enlarged from its present capacity of 1,600 acre-feet to 2,000 acre-feet.

Land treatment measures can be applied to the upper watersheds for effective erosion and sediment controls. On-farm land treatment would be effective in helping solve agricultural water management problems. Limitations on potential development relate to available water supplies.

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed receives technical assistance through the Upper Sevier and Canyon Lands Soil Conservation Districts.

In 1955, the local people submitted an application for assistance in developing a work plan through PL-566. This application covered 67,100 acres of the watershed. The local organization included representatives of the East Fork Graziers Association, East Fork Irrigation Company, Cannonville Water Users, Tropic Water Users, Cannonville Irrigation Company, and the Paria River and Upper Sevier Soil Conservation Districts. These organizations would be the nucleus of any new organization formed for the purpose of developing the watershed. Through their past and present organizations, they have exhibited their ability to function administratively and financially.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT

Land treatment measures for the upper watershed area applicable for acceleration under a project are as follows: Sagebrush spraying, trenching and seeding, contour furrowing and seeding, plowing and seeding, pinyon-juniper removal and seeding, vegetation planting for channel stabilization, grass waterways, and gully plugs.

Land treatment on the irrigated lands is primarily land leveling. This is to cope with sediment buildup which causes excessive operation and maintenance costs. Ditch lining and other water management practices are also applicable to the irrigated farm lands.

STRUCTURAL MEASURES

Tropic Reservoir is to be enlarged by 400 acre-feet, increasing the net capacity from 1,600 acre-feet to 2,000 acre-feet. The required 100-year sediment storage is 370 acre-feet. The additional capacity will be utilized for irrigation water storage. (Table 52)

TABLE 52.--Structure data - storage capacity, Tropic Watershed (E-5), Sevier River Basin

Item	Unit	Value or material
Site number		E5-1
Site name		Tropic Reservoir Enlargement
Class of structure		"B"
Drainage area	Square miles	87.5
Elevation top of dam		
Present	Feet	7,806.5
Enlargement	Feet	7,909.0
Elevation crest emergency spillway		
Estimated present	Feet	7,801.0
Enlargement	Feet	7,803.5
Sediment pool elevation		
Estimated present	Feet	7,789
Enlargement	Feet	7,793
Volume of fill		
Enlargement (net increase)	Cubic yards	27,500
Total capacity		
Present	Acre-feet	1,600
Enlargement	Acre-feet	2,000
Sediment submerged		
1st 50 years	Acre-feet	160
2nd 50 years	Acre-feet	140
Sediment aerated	Acre-feet	70
Irrigation storage (at end of 100-year period)	Acre-feet	1,630
Surface areas (enlarged)		
Maximum (emergency spillway)	Acres	185
Minimum (sediment pool)	Acres	120
Emergency spillway		
Type		Conc.
Chance use	Percent	50
Principal spillway		
Type		R/C Conduit
Release rate	CSM	10

A pipeline in Water Canyon will arrest the existing sediment problem. This line will consist of 1,650 feet of 18 to 24-inch diameter reinforced-concrete pipe.

Canal lining will be placed on 4 miles of the distribution systems of the irrigation companies.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

STRUCTURAL MEASURES

Capacities of Site E5-1, Tropic Reservoir Enlargement, were determined from available storage tables obtained from previous surveys. Sediment rates were based on past entrapment in existing sites. Quantities were based on existing topographic information. (Table 53 and 54)

Pipeline and canal lining project costs and quantities were estimated from limited field information. Sizes were based on anticipated and existing flows.

Unit costs for the improvements were based on similar Utah developments.

ENGINEERING SERVICES

Engineering services are estimated at 12.5 percent of construction costs.

EASEMENTS AND RIGHTS-OF-WAY

The developments are on existing rights-of-way and there will be negligible costs involved in further development.

TABLE 53.--Estimated structural cost-potential development,[a] Tropic Watershed (E-5), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Reservoirs			
Site E5-1, Tropic Reservoir Enlargement	Each	1	27,500
Pipeline	Linear feet	1,700	14,000
Canal lining	Miles	4	103,000
Total			144,500
Engineering services			17,340
Land easements & rights-of-way			300
Grand total			162,140

[a]Price Base 1967.

TABLE 54.--Distribution of structural cost-potential development,[a] Tropic Watershed (E-5), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Site E5-1, Tropic Reservoir Enlargement	27,500	3,300	100	30,900
Pipeline	14,000	1,680	100	15,780
Canal lining	103,000	12,360	100	115,460

[a]Price Base 1967.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs were based on the expected life and repair cost for each development. (Table 55)

COST ALLOCATION

The use of facilities method was used to allocate costs of improvements. (Table 56)

PROJECT ADMINISTRATION

Project administration as a total was estimated as 13 percent of construction costs.

E F F E C T S A N D E C O N O M I C F E A S I B I L I T Y O F P O T E N T I A L D E V E L O P M E N T

The on-farm land treatment measures were assumed feasible at 1:1 benefit cost ratio. The effects of on-farm land treatment should raise on-farm water-use efficiency from 43 percent at present to 54 percent with project measures.

Lining of 4 miles of conveyance system canal will increase transportation efficiency from 70 percent to 79 percent. The diversion to root-zone efficiency will increase 5 percent as a result of canal lining. This will increase root-zone supplies by 332 acre-feet. Value of root-zone water is estimated at $36.60 per acre-foot giving an annual benefit for canal lining of $12,150. Secondary benefits are $1,825 per year. Average annual costs are $6,990, which yield a benefit cost ratio of 2.0:1. (Table 57)

The Water Canyon pipeline will increase conveyance efficiency from 79 percent with canal lining to 82 percent with pipeline plus canal lining. This equals 1 percent increase in total efficiency and yields 68 acre-feet additional root-zone water which will produce an annual benefit of $2,490.

TABLE 55. --Annual costs,[a] Tropic Watershed (E-5), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Site E5-1, Tropic Reservoir Enlargement	1,040	140	1,180
Pipeline	530	170	700
Canal lining	3,900	3,090	6,990
Project administration	---	---	640
Grand total	---	---	9,510

[a]Price Base 1967.

[b]100 years @ 3¼ percent interest.

TABLE 56.--Cost allocation and cost sharing summary,[a] Tropic Watershed (E-5), Sevier River Basin

Item	Cost allocation		Cost sharing			
	Purpose		Federal		Nonfederal	
	A.W.M.	Total	A.W.M.	Total	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Site E5-1, Tropic Reservoir Enlargement	30,900	30,900	17,000	17,000	13,900	13,900
Pipeline	15,780	15,780	8,680	8,680	7,100	7,100
Canal lining	115,460	115,460	63,860	63,860	51,600	51,600
Grand total	162,140	162,140	89,540	89,540	72,600	72,600

[a]Price Base 1967.

An additional benefit from the pipeline is the saving of 200 acre-feet of water used each year to sluice sediment. This additional water will yield 88 acre-feet to the root zone for benefits of $3,220. The combined benefits from the pipeline will be $5,710. Secondary benefits are $860. Annual cost is $700, and the benefit cost ratio for this increment of project is 9.4:1.

Enlargement of Tropic Reservoir will increase the storage capacity by 400 acre-feet. The 100-year average diversion will be increased 200 acre-feet per year and the remainder will be used for sediment storage. The 200 acre-foot diversion will yield 88 acre-feet to the root zone with annual benefits of $3,220. Secondary benefits are $480. Total annual benefits from reservoir enlargement are $3,700. Average annual costs are $1,180 and the benefit cost ratio for the reservoir enlargement is 3.1:1. Benefits for sediment storage in the enlarged reservoir were not evaluated.

Land treatment and project measures were designed around an open channel, flood irrigation system. Although not evaluated, the watershed may have a potential for installing a sprinkler irrigation system. This would increase efficiencies and make more of the diversions available to be consumptively used by crops.

Redevelopment benefits and national secondary benefits were not evaluated.

Total local secondary benefits are $3,165 for all project measures.

The ratio of average annual benefits to average annual cost for all works of improvement, including primary and local secondary benefits, is 2.5:1. The benefit cost ratio, excluding local secondary benefits, is 2.2:1.

TABLE 57.--Comparison of benefits and costs,[a] Tropic Watershed (E-5), Sevier River Basin

Evaluation units	Average annual benefits			Total benefits	Average annual cost[b]	Benefit cost ratio
	Sediment control	A.W.M.	Secondary			
	Dollars	Dollars	Dollars	Dollars	Dollars	
Canal lining	---	12,150	1,830	13,980	6,990	2.0:1
Pipeline	3,220	2,490	860	6,570	700	9.4:1
Site E5-1, Tropic Reservoir Enlargement	---	3,220	480	3,700	1,180	3.1:1
Project administration	---	---	---	---	640	---
Grand total	3,220	17,860	3,170	24,250	9,510	2.5:1

[a]Price Base 1967.

[b]From Table 55.

CIRCLEVILLE WATERSHED (F-1)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
GARFIELD AND PIUTE COUNTIES, UTAH
June 1968

T H E W A T E R S H E D I N B R I E F

The watershed is located in Garfield and Piute Counties, Utah, and contains 92,900 acres. It is tributary to and comprises 1.8 percent of the area covered by the Sevier River Basin. Total watershed acres are distributed among private lands, 35,067 acres; Federal lands administered by the Bureau of Land Management, 16,700 acres; and Fishlake and Dixie National Forest lands, 41,133 acres. The watershed had a 1960 census population of 490 people, 478 of them were living in the town of Circleville. The population trend has been decreasing for the past 18 years. (Figure 20)

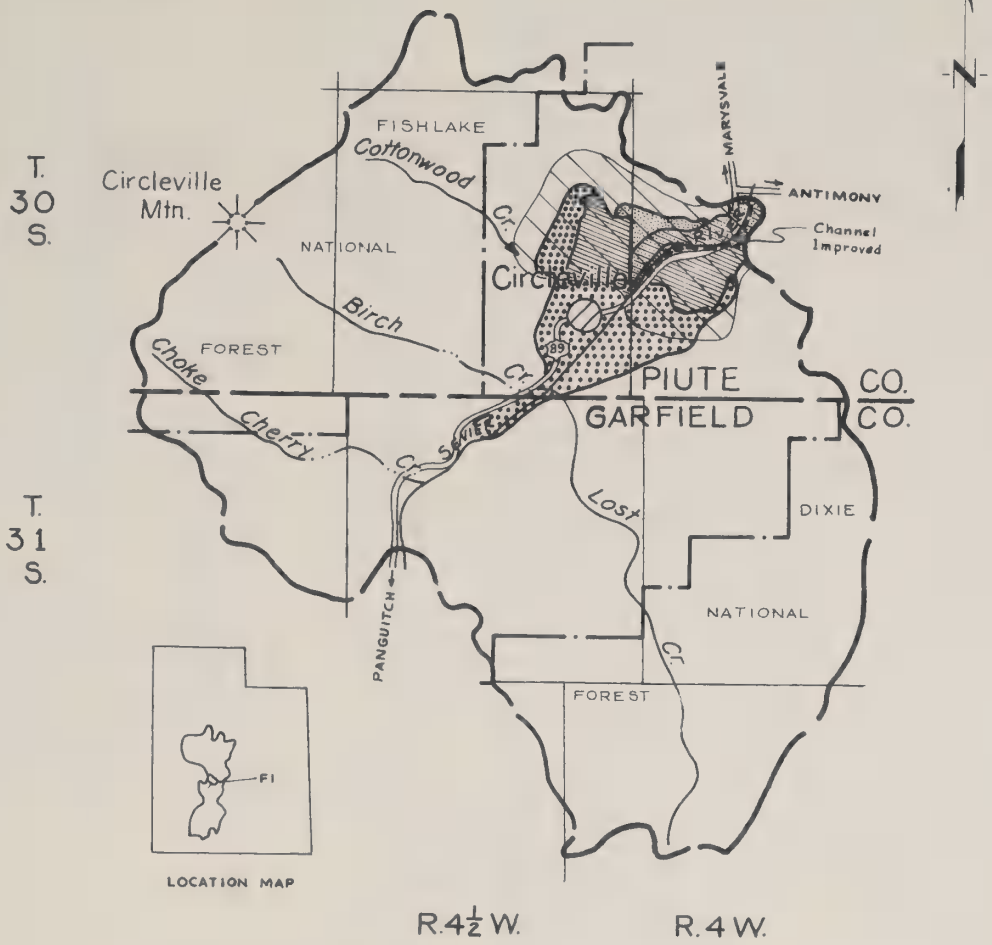
The basic crop production comes from 6,260 acres of irrigated rotation croplands. Of this cropland, approximately 78 percent is alfalfa and improved pasture, 13 percent small grains, 6 percent potatoes, and 3 percent corn silage crops.

There are a number of pumped wells, primarily small-diameter stockwater wells. One well is used for irrigation purposes and yields an average of 500 acre-feet annually.

The normal annual precipitation varies from 8 to 35 inches depending on elevations. The annual precipitation on irrigated croplands is 9 inches with the summer months receiving the greatest portion. Elevations range from 5,990 feet to 11,440 feet. Irrigation water comes from the South fork of the Sevier River from which their average annual diversion is 29,000 acre-feet.

The soils of the watershed include: High Mountain range sites with Cryoboroll and Cryoboralf soils, 18 percent; Mountain range sites, Cryoboroll soils, 20 percent; Upland range sites, Argiustoll, Calciustoll, and Haplustoll soils, 30 percent; Semidesert range sites with Torrifluvent and Calciorthent soils, 35 percent; and Wetlands that are Haplaquepts, 7 percent. The vegetation varies and includes aspen, conifer, pinyon-juniper, oak browse range, and sagebrush.

The Circleville watershed is a circular valley surrounded by the Tushar Range to the west and the Sevier Plateau to the east. Geologically, Circle Valley is a graben block bordered on the west by the Tushar fault and on the east by the Sevier fault. The subsidence of



LEGEND

- WATERSHED BOUNDARY
- RESERVOIR SITE
- FI-7 INDEX NUMBER
- CHANNEL
- NATIONAL FOREST BOUNDARY
- POPULATION CENTER
- ROADS, PRIMARY
- RAILROADS
- COUNTY LINE
- POTENTIAL WATER SALVAGE AREA
- IRRIGATED ROTATION CROPLAND
- IRRIGATED - WETLANDS
- MIXED WETLANDS
- NON IRRIGATED GRASSLANDS - WETLAND

FIGURE 20

PROJECT LOCATION MAP
CIRCLEVILLE WATERSHED (F-1)

Sevier River Basin
Utah
June 1968

the valley was caused by the ejection of magma from beneath the surface along with down-faulting of the block. The Tushar Range consists almost entirely of Tertiary volcanic material of this same age. Underlying the volcanic cap of the plateau are flat lying sedimentary strata with few disconformities and some gentle dips to the east. The valley floor consists of Quaternary alluvial deposits.

The Larimide orogeny has been the major contributor to the relief of this area with minor relief features due to volcanic activity.

W A T E R S H E D P R O B L E M S A N D N E E D S

FLOOD PREVENTION

Flood damages are minor as most floods from the drainages are dissipated on alluvial fans and through existing training dikes.

AGRICULTURAL WATER MANAGEMENT

With existing efficiencies, water supplies are adequate to meet the needs of the presently irrigated cropland about one-half the time. Shortages occur which may be as high as 22 percent of the 13,830 acre-foot potential consumptive use. Losses in the distribution systems as well as low on-farm irrigation efficiencies contribute to this problem. Open-ditch irrigation systems have an average annual loss of 11,800 acre-feet of water.

There are 3,400 acres of wetlands which have an average annual consumptive use of 7,000 acre-feet. This is a low economic use of this water.

EROSION AND SEDIMENT

Erosion is a serious problem on many areas where vegetation does not adequately protect the soil. This lessens the productivity and makes it increasingly difficult to restore and maintain a good vegetation-soil-water hydrologic relationship. Steep slopes and high intensity rainfall add to the problem. There is heavy to excessive erosion

on 33,450 acres. About 1,850 acres are subject to geologic erosion. Streambank erosion also contributes heavily to the sediment yield (Figure 21).

LAND TREATMENT

Land treatment on upper watershed lands is needed to correct unsatisfactory watershed conditions resulting from excessive erosion and unstable soils. This will reduce sediment yields and lower flood peaks.

Land treatment needs on irrigated lands are water management oriented. These needs are related to sediment deposits and conveyance problems.

PHYSICAL POTENTIAL FOR MEETING NEEDS

Water supplies to the watershed are more than adequate to overcome water shortages, irrigate idle arable land, and to supply additional water needed to accomplish a conversion of wetland to irrigated rotation cropland.

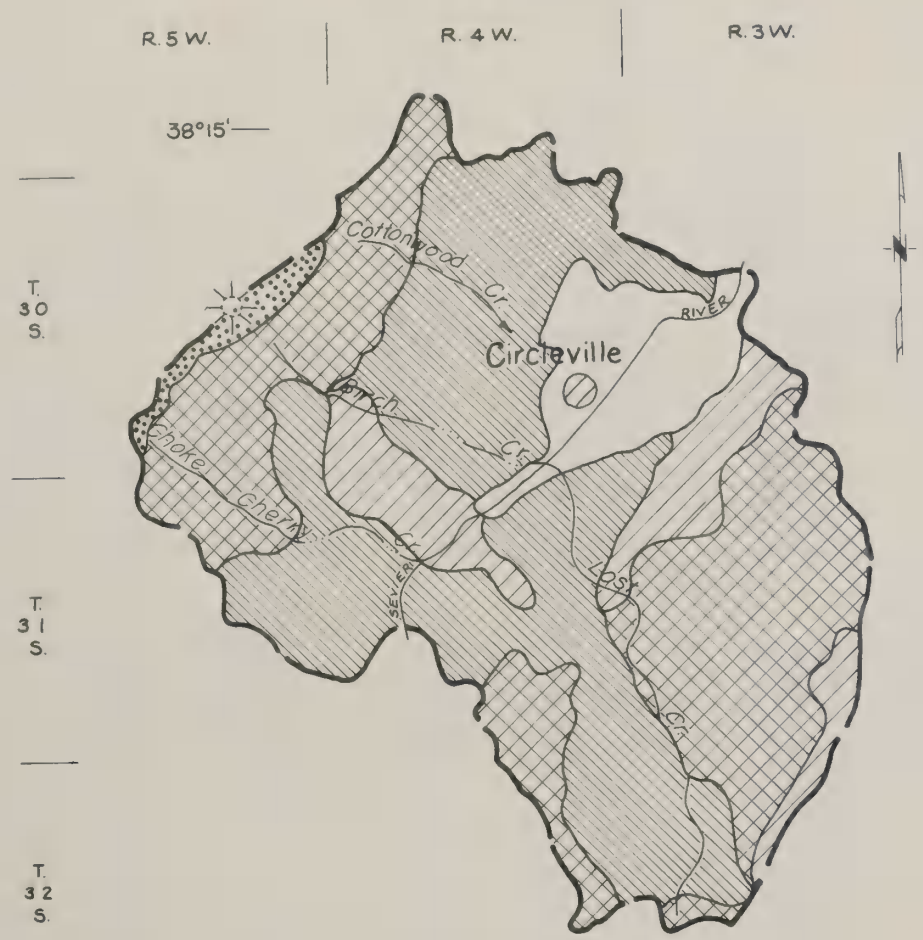
Groundwater reserves are available to supply 16 wells of 5 c.f.s. capacity that can be used to replenish surface flows for downstream use.

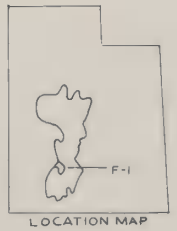
The canal systems can be effectively concrete lined to reduce seepage loss and operation and maintenance costs.

There are 5,000 acres of irrigable land which does not now have a water supply.

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed receives technical assistance through the Piute County Soil Conservation District. The conservation district, Circleville community, Loss Creek Irrigation Company, and Circleville Irrigation Company are particularly interested in water-based developments. This local interest could result in an application for and eventual construction of a small watershed project.





LEGEND

- Incipient Erosion
- Light to Moderate Erosion
- Heavy to Excessive Erosion
- Geological Erosion
- Unclassified

FIGURE 21

EROSION CONDITION MAP CIRCLEVILLE WATERSHED(F-1)

Sevier River Basin
Utah
June 1968

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT

Land treatment measures on the upper watershed areas applicable for acceleration under a project are as follows: Pinyon-juniper removal and seeding, sagebrush removal and seeding, furrow and reseeding, plow and seed, contour trench and seed, aerial spray, aerial spray-harrow and seed, and gully plugs.

Land treatment for the irrigated lands are primarily land leveling. This is to cope with sediment buildup which causes excessive machinery operations and maintenance costs. Ditch lining and other water management practices are also applicable to the irrigated farm lands.

STRUCTURAL MEASURES

The development will include 15 miles of canal lining with capacities from 10 c.f.s. to 60 c.f.s. These canals are to service the present irrigated rotated lands and 4,170 acres of secondary lands. Six miles of pipeline with capacities to 60 c.f.s. and six pumping units will deliver water from the Loss Creek canal to the secondary lands through sprinklers. Two miles of pipelines and sprinklers will be installed to supply 1,680 acres of converted wetlands. The supply to these lands will be provided from 5 wells, each with about 5 c.f.s. capacity.

NATURE AND ESTIMATE OF COSTS OF IMPROVEMENTS

STRUCTURAL DEVELOPMENTS

Quantities and sizes were based on present conditions and anticipated conditions. Investigation were only made to the extent of determining the magnitude of possible development. Cost estimates are based on similar developments in Utah. (Table 58 and 59)

TABLE 58.--Estimated structural cost-potential development,[a] Circleville Watershed (F-1), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Canal lining	Miles	15	300,000
Pipelines	Miles	8	200,000
Wells	Each	5	94,000
Total			594,000
Engineering services			71,300
Land easements & rights-of-way			400
Grand total			665,700

[a]Price Base 1967.

TABLE 59.--Distribution of structural cost-potential development,[a] Circleville Watershed (F-1), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Canal lining	300,000	36,000	100	336,100
Pipeline	200,000[b]	24,000	100	224,100
Wells	94,000	11,300	200	105,500

[a]Price Base 1967.

[b]Includes 6 pump units.

ENGINEERING SERVICES

Engineering services are estimated at 12.5 percent of construction cost.

EASEMENTS AND RIGHTS-OF-WAY

The developments are to be placed on present rights-of-way and will result in minimal legal and easement costs. Rights-of-way for drilling wells were not included but should be obtainable when detailed investigations determine exact locations.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs are based on the expected life and repair costs for each development. Pumping costs for the wells were included in their operation costs. (Table 60)

COST ALLOCATION

The use of facilities method was used to allocate costs of the developments. (Table 61)

PROJECT ADMINISTRATION

The costs of administering contracts were estimated as 13 percent of the construction costs.

E F F E C T S A N D E C O N O M I C F E A S I B I L I T Y O F P O T E N T I A L D E V E L O P M E N T

The 15 miles of canal lining will provide 1,350 acre-feet of additional root-zone water to 4,580 acres of presently irrigated rotated

TABLE 60.--Annual costs,[a] Circleville Watershed (F-1), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Canal lining	11,400	9,000	20,400
Pipelines	7,600	55,500[c]	63,100
Wells	3,600	18,000[c]	21,600
Project administration	---	---	2,600
Grand total	---	---	107,700

[a]Price Base 1967.

[b]100 years @ 3¼ percent interest.

[c]Includes pumping costs.

TABLE 61.--Cost allocation and cost sharing summary,[a] Circleville Watershed (F-1), Sevier River Basin

Item	Cost allocation		Cost sharing			
	Purpose		Federal		Nonfederal	
	A.W.M.	Total	A.W.M.	Total	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Canal lining	336,100	336,100	186,000	186,000	150,100	150,100
Pipeline	224,100	224,100	124,000	124,000	100,100	100,100
Wells	105,500	105,500	11,300	11,300	94,200	94,200
Grand total	665,700	665,700	321,300	321,300	344,300	344,300

[a]Price Base 1967.

cropland. This is an increase of 8 percent more water at the root zone. At $35 per acre-foot, benefits are $47,250 per year. Estimated local secondary benefits are $7,100. The benefit cost ratio for canal lining is 2.7:1. (Table 62)

The diversion rights will allow conversion of secondary lands to irrigated rotated cropland with the same cropping pattern as found on presently irrigated lands. The location of these 4,170 acres of land is most suitable for sprinkler irrigation systems. The change from present conditions to project conditions would yield an annual benefit of $62,300. The water will be pumped out of the canal system at various locations. Efficiency of conveyance was considered in the evaluation but the cost of canal system lining was all charged to presently irrigated rotation cropland. Local secondary benefits for the pipeline for converted lands are $9,300. Benefit cost ratio for pipeline evaluation unit is 1.1:1. Residual benefits for land treatment assumed cost and benefit equal to 1:1. The costs were therefore taken from gross benefits and all differences were project benefits.

Five wells are located within the wetlands area to aid in controlling the water table and for supplying irrigation water to these same lands and to compensate for downstream effects. They will supply 6,000 acre-feet annually, 1,700 of which is to compensate for downstream effects.

The change from present annual return on wetlands and project conditions is estimated to provide an annual benefit of $19,250. Local secondary benefits are $2,900 per year.

Redevelopment benefits and national secondary benefits were not evaluated. Total local secondary benefits are $19,300.

The ratio of average annual benefits to average annual costs for all works of improvement, including primary and local secondary benefits is 1.4:1. The benefit cost ratio, excluding local secondary benefits, is 1.2:1.

TABLE 62.--Comparison of benefits and costs,[a] Circleville Watershed (F-1), Sevier River Basin

Evaluation unit	Average annual benefits		Total benefits	Average annual cost[b]	Benefit cost ratio
	A.W.M.	Secondary			
	Dollars	Dollars	Dollars	Dollars	
Canal lining	47,250	7,100	54,350	20,400	2.7:1
Pipeline	62,300	9,300	71,600	63,100	1.1:1
Wells	19,250	2,900	22,150	21,600	1.0:1
Project administration	---	---	---	2,600	---
Grand total	128,800	19,300	148,100	107,700	1.4:1

[a]Price Base 1967.

[b]From Table 60.

PANGUITCH CREEK WATERSHED (F-3)
WATERSHED INVESTIGATION REPORT
SEVIER RIVER BASIN
GARFIELD AND IRON COUNTIES, UTAH
May 1968

T H E W A T E R S H E D I N B R I E F

This watershed is located in Garfield and Iron Counties and contains 139,500 acres: Private lands, 10,720 acres; state lands, 4,720 acres; Federal lands administered by the Bureau of Land Management, 31,458 acres; and Dixie National Forest lands, 92,602 acres. It is a tributary to the Sevier River and comprises 2.7 percent of the Sevier River Basin. The watershed had a 1960 census population of 1,452 people; 1,435 of them were in the town of Panguitch. The 1940 to 1960 population trend has been declining. (Figure 22)

The basic crop production comes from 4,070 acres of irrigated rotation cropland. Of this, 80 percent is alfalfa hay and 20 percent is small grain crops. The normal annual precipitation varies from 10 inches in the lower elevations to 35 inches in the higher elevations. The irrigated rotation cropland receives from 10 to 11 inches. Elevations range from 6,600 to 11,300 feet.

The watershed includes Semidesert range sites with Torrifluvent, Calciorthid and Haplargid soils, approximately 10 percent of the area; Mountain range sites with Cryoboroll soils, 20 percent; Upland range sites with Argiustoll, Calciustoll and Haplustoll soils, 30 percent; and High Mountain range sites with Cryoboroll and Cryoboralf soils, 30 percent.

The vegetation is sagebrush, pinyon-juniper, aspen, conifer, and oak browse.

There is a large area of undifferentiated Tertiary volcanic rocks and smaller areas of the Brian Head, Wasatch and Sevier River formations. There are also areas of Quaternary basalt, late and early Tertiary andesite-trachyte-latite proclastics. The watershed does have some minor faulting.

The only major reservoir, Panguitch Lake, is located on Panguitch Creek and provides irrigation storage and recreation. It has a capacity of 18,500 acre-feet with a surface area of 1,230 acres. It controls approximately 53 square miles of drainage.

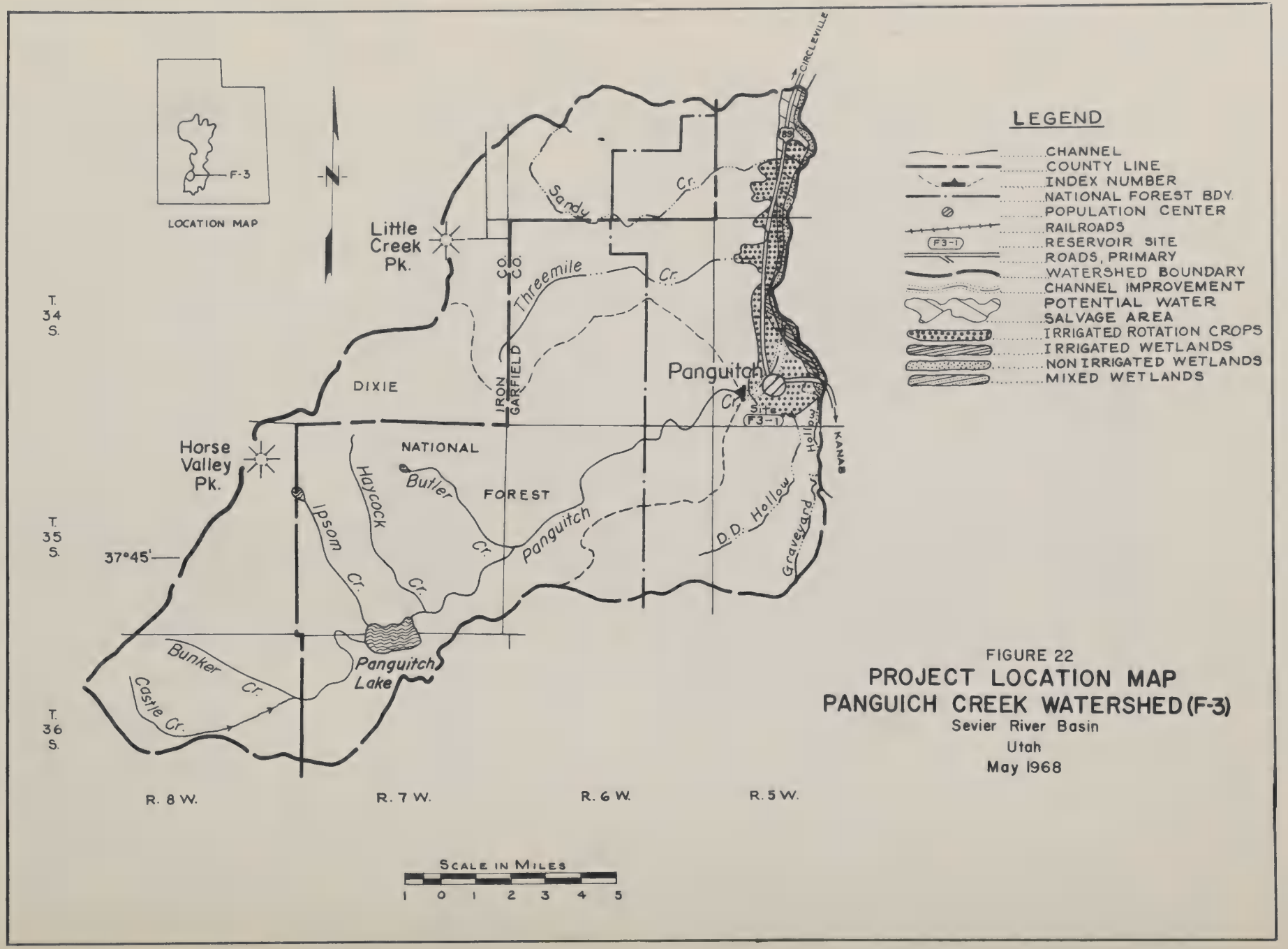


FIGURE 22

PROJECT LOCATION MAP
PANGUICH CREEK WATERSHED (F-3)

Sevier River Basin
Utah
May 1968

The major sources of irrigation water are from the Sevier River and Panguitch Creek. Distribution of water is made through the systems of the West Panguitch Irrigation Company, the Barton, LeFevre, Tebbs Irrigation Company, and a number of one-owner systems.

W A T E R S H E D P R O B L E M S A N D N E E D S

FLOOD AND SEDIMENT DAMAGES

Damaging floods have occurred from the five major drainages in the watershed: Graveyard Hollow, D. D. Hollow, Panguitch Creek, Three-Mile Creek, and Sandy Creek. These have resulted in an average annual damage of $4,300. Past damages were mostly confined to the irrigation systems. Flood damages from Panguitch and Three-Mile Creeks occur almost yearly and are confined largely to the West Panguitch Irrigation Company system.

The city of Panguitch has a winter ice problem that causes traffic and everyday living inconveniences. Freezing and thawing conditions eventually block Panguitch Creek prohibiting continuous water flow. Continued ice accumulation encroaches on resident property and city maintenance crews are hampered by the ice in attempting to keep roads and streets accessible during the winter.

Canal breakage due to ice problems results in a yearly water loss of 175 acre-feet.

Panguitch Creek channel through Panguitch is in need of cleaning and improvement. Presently, debris and vegetative growths are restricting flood flows. Also, there is a need for a flood detention structure on Panguitch Creek. Other than the Panguitch Creek floods, minor damages have occurred to agriculture land and U. S. Highway 89.

EROSION

Erosion is a serious problem on many areas where vegetation does not adequately protect the soil, a condition partly attributed to past heavy grazing. This lessens the productivity and makes it increasingly difficult to restore a good vegetation-soil-water hydrologic relationship. Steep slopes and high intensity rainfall add to the problem. There is heavy to excessive erosion on 22,000 acres. Streambank erosion also contributes heavily to the sediment yield. Refer to Figure 23.

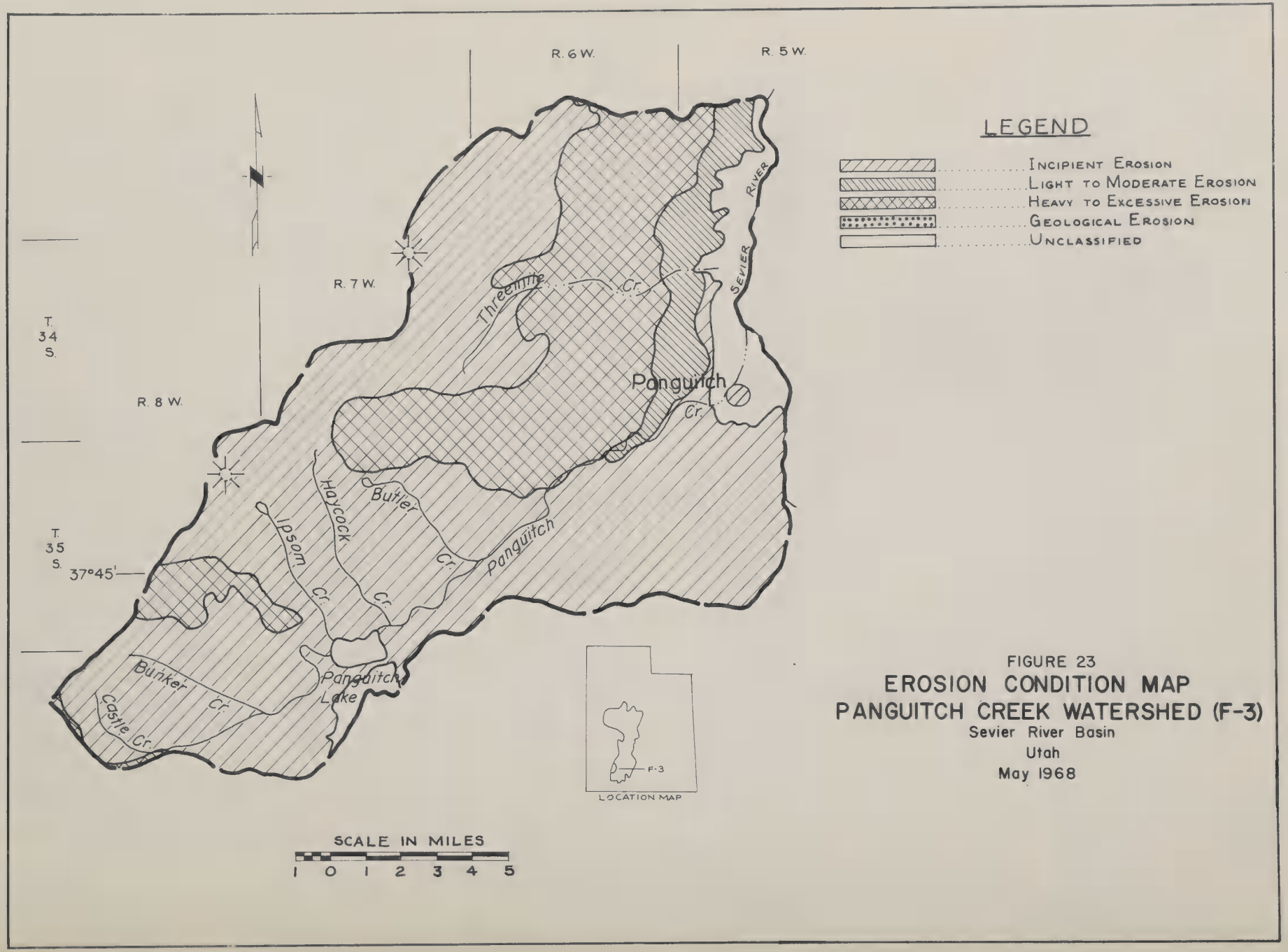


FIGURE 23
EROSION CONDITION MAP
PANGUITCH CREEK WATERSHED (F-3)
Sevier River Basin
Utah
May 1968

LAND TREATMENT

Land treatment on upper watershed lands is needed to correct unsatisfactory watershed conditions resulting from excessive erosion and unstable soils. This will help reduce sediment yields and lower flood peaks.

Land treatment needs on irrigated lands are water management oriented. They include land leveling and ditch lining. These needs are related to sediment deposits and conveyance problems.

AGRICULTURAL WATER MANAGEMENT

There are major diurnal fluctuations throughout the irrigation season. A regulatory reservoir readily accessible to water users and conversion to call system deliveries could reduce the root-zone deficit approximately 60 acre-feet a year.

The present overall efficiencies of the irrigation systems are 30 percent. Canal lining, consolidation of some distribution canals, and land leveling are needed to increase efficiencies and reduce operation and maintenance costs. Such improvements can provide 200 acre-foot additional root-zone water per year. Below are calculated root-zone deficits for the presently irrigated lands.

Chance supply	Deficit
Percent	Acre-feet
80	480
90	990
95	1,415

PHYSICAL POTENTIAL FOR MEETING NEEDS

There is a possibility of providing irrigation water storage-regulation, flood storage and recreation facilities at Site F3-1, West Panguitch. Other than this site, the opportunities of reservoir storage of major capacities are limited.

Canal lining can be effectively installed for the distribution systems of the watershed.

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed receives technical assistance through the Upper Sevier River Soil Conservation District. Local sponsors have submitted a watershed application for planning assistance under the title "Panguitch-Three-Mile Creek Watershed" but legal requirements have temporarily halted planning. Panguitch residents are vitally interested in improvement projects to protect culinary water, improve regulation of irrigation water, eliminate winter ice damage, and provide flood protection.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

LAND TREATMENT

Land treatment measures for the upper watershed areas applicable for acceleration under a project are: Pinyon-juniper removal and grass seeding, contour trenching, and grass seeding, pitting and grass seeding, Ponderosa pine plantings and gully plugs.

Land treatment for the irrigated lands is primarily land leveling. This is to cope with the sediment buildup which causes excessive operation and maintenance costs. Ditch lining and other water management practices are also applicable to the irrigated farm lands.

STRUCTURAL MEASURES

The primary features for potential development are channel improvement on Panguitch Creek, Site F3-1, West Panguitch, and canal lining. Site F3-1 would include storage capacity for irrigation water, flood detention (50-year storm) and a recreation pool. The channel improvement from this structure to the Sevier River will provide additional flood capacity and provide 100-year frequency storm protection. (Table 63 and 64)

TABLE 63.--Channel data, Panguitch Creek Watershed (F-3), Sevier River Basin

Item	Unit	Value or material
Channel designation		Panguitch Creek Channel Improvement
Length of reach	Miles	2
Watershed area	Square miles	13.0
Needed channel capacity	C.F.S.	1,200
Bottom width	Feet	25
Depth	Feet	5
Velocity in channel	Feet/second	6.0
Estimated volume of excavation	Cubic yards	20,000

TABLE 64.--Reservoir storage capacity and structure data, Panguitch Creek Watershed (F-3), Sevier River Basin

Item	Unit	Value or material
Site number		F3-1
Site name		West Panguitch Reservoir
Class of structure		"C"
Drainage area	Square miles	61
Estimated height of dam	Feet	45
Estimated volume of fill	Cubic yards	110,000
Principal spillway		
Type		R/C Conduit
Release rate	CSM	10
Emergency spillway		
Type		Conc.
Chance of use	Percent	2
Surface areas		
Recreation pool	Acres	17
Emergency spillway crest	Acres	34
Capacities		
Sediment	Acre-feet	50
Flood detention	Acre-feet	225
Flood prevention total	Acre-feet	275
Recreation	Acre-feet	150
Irrigation	Acre-feet	75
Total capacities	Acre-feet	500
Additional storage capacity available	Acre-feet	110

Canal lining, in addition to on-farm land treatments, will aid in increasing irrigation system efficiency. There are 18 miles of main distribution canals to be lined as well as consolidation of distribution systems.

N A T U R E A N D E S T I M A T E O F C O S T S O F I M P R O V E M E N T S

STRUCTURAL DEVELOPMENTS

Construction costs for normal conditions were applied for all structural developments. Contingency factors of 25 percent and 15 percent were applied to Site F3-1, West Panguitch Reservoir, and the canal lining, respectively. Sizes and quantities were determined without field investigations. (Table 65 and 66)

ENGINEERING SERVICES

The engineering services costs were estimated at 12 percent of the construction costs.

EASEMENTS AND RIGHTS-OF-WAY

Canal lining rights-of-way costs will be small as the improvements would be along existing rights-of-way. For Site F3-1, West Panguitch, and the channel improvement area, the costs are for purchase of property and rights-of-way.

REPLACEMENT, OPERATION, AND MAINTENANCE

These costs were based on the expected life and repair costs for each item. (Table 67)

TABLE 65.--Estimated structural cost-potential development,[a] Panguitch Creek Watershed (F-3), Sevier River Basin

Item	Unit	Amount planned	Estimated total cost
			Dollars
Structural measures			
Construction			
Multiple-purpose structures	Each	1	125,000
Recreation developments	Each	1	17,750
Canal lining	Miles	18	268,260
Channel improvement	Miles	2	22,500
Total			433,510
Engineering services			52,020
Land easements & rights-of-way			10,930
Grand total			496,460

[a]Price Base 1967.

TABLE 66.--Distribution of structural cost-potential development,[a] Panguitch Creek Watershed (F-3), Sevier River Basin

Structural measures	Construction	Engineering services	Land easements & rights-of-way	Installation costs
	Dollars	Dollars	Dollars	Dollars
Site F3-1, West Panguitch Reservoir	125,000	15,000	8,750	148,750
Recreation facilities	17,750	2,130	500	20,380
Panguitch Creek Channel Improvement	22,500	2,700	1,580	26,780
Canal lining	268,260	32,190	100	300,550

[a] Price Base 1967.

TABLE 67.--Annual costs,[a] Panguitch Creek Watershed (F-3), Sevier River Basin

Evaluation unit	Amortization of installation cost[b]	Replacement operation and maintenance	Total
	Dollars	Dollars	Dollars
Site F3-1, West Panguitch Reservoir	5,040	750	5,790
Recreation facilities	690	600	1,290
Panguitch Creek Channel Improvement	910	300	1,210
Canal lining	10,190	9,000	19,190
Project administration	---	---	1,900
Grand total	---	---	29,380

[a]Price Base 1967.

[b]100 years @ 3¼ percent interest.

TABLE 68.--Cost allocation and cost sharing summary,[a] Panguitch Creek Watershed (F-3), Sevier River Basin

Item	Cost allocation				Cost sharing							
	Purpose				Federal				Nonfederal			
	Flood & sediment	Recreation	A.W.M.	Total	Flood & sediment	Recreation	A.W.M.	Total	Flood & sediment	Recreation	A.W.M.	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Site F3-1, West Panguitch Reservoir	81,810	44,630	22,310	148,750	77,000	42,000	21,000	140,000	4,810	2,630	1,310	8,750
Recreation Facilities	---	20,380	---	20,380	---	11,000	---	11,000	---	9,380	---	9,380
Panguitch Creek Channel Improvement	26,780	---	---	26,780	25,200	---	---	25,200	1,580	---	---	1,580
Canal lining	---	---	300,550	300,550	---	---	166,320	166,320	---	---	134,230	134,230
Grand total	108,590	65,010	322,860	496,460	102,200	53,000	187,320	342,520	6,390	12,010	135,540	153,940

[a]Price Base 1967.

COST ALLOCATION

The use of facilities method was used to allocate costs. (Table 68)

PROJECT ADMINISTRATION

This cost was estimated as 13 percent of the construction costs.

E F F E C T S A N D E C O N O M I C F E A S I B I L I T Y O F P O T E N T I A L D E V E L O P M E N T

With the level of development described for Site F3-1, West Panguitch, and Panguitch Creek channel improvement, the community and rural areas will receive 100-year frequency flood protection and other damages will be reduced approximately $2,835 per year. Site F3-1, West Panguitch, will also provide 58 acre-feet additional root-zone water from increased efficiency through regulation. Estimated benefits are $2,220 per year. Recreation potential at Site F3-1, West Panguitch, will provide a minimum of 17 surface acres and 150 acre-feet for permanent fish culture. Estimated fishing benefits are $1,700. The benefit cost ratio for this structure with primary and secondary benefits is 1.3:1. (Table 69)

The campground facilities for 15 family units and 1 group unit will provide annual benefits of $3,000. The benefit cost ratio is 2.7:1.

System improvement will eliminate the present average annual 200 acre-feet of root-zone deficit. An additional benefit will result from changed cropping pattern and labor savings. Total annual estimated agricultural water management benefits associated with canal lining is $16,030. The benefit cost ratio for canal lining for primary and secondary combined is 1.1:1.

It is assumed that there would not be any change in land use in the flood plain. Land enhancement benefits were not evaluated. Local secondary benefits for Site F3-1, West Panguitch, are $1,150. Local secondary benefits for the campground are $450 and for canal lining are $4,955 per year. Total local secondary benefits are $6,555.

The benefit cost ratio for all works of improvement, including primary and local secondary benefits, is 1.1:1. The benefit cost ratio excluding local secondary benefits is 0.9:1.

TABLE 69.--Comparison of benefits and costs for structural measures,[a] Panguitch Creek Watershed (F-3), Sevier River Basin

Evaluation units	Average annual benefits				Total benefits	Average annual cost[b]	Benefit cost ratio
	Flood damage reduction	A.W.M.	Recreation	Secondary			
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	
Site F3-1, West Panguitch Reservoir & Panguitch Creek Channel Improvement	3,735	2,220	1,700	1,150	8,805	7,000	1.3:1
Campgrounds	---	---	3,000	450	3,450	1,290	2.7:1
Canal lining	---	16,030	---	4,955	20,985	19,190	1.1:1
Project administration	---	---	---	---	---	1,900	---
Grand total	3,735	18,250	4,700	6,555	33,240	29,380	1.1:1

[a] Price Base 1967.

[b] From Table 67.

ALTERNATE OR ADDITIONAL POSSIBILITIES

Coordinated planning with Watersheds F-1 and F-2 is recommended for long-range developments. This would permit full development of common groundwater reservoirs and utilization of return flows from irrigation systems.

Planning for Site F3-1 could be altered to exclude flood detention if Panguitch Channel improvements were expanded.

ADDENDUM

Method of changing annual costs from present analysis to other interest rates

The Watershed Investigation Reports show results of project evaluations at 3¼ percent interest. Since interest rates are subject to change each July 1, a simple adjustment curve was developed so that the reader could recompute annual costs at varying interest rates between three and eight percent. Actual annual cost computations would be slightly less than those computed by extrapolating from the curve for canal lining but more for reservoirs.

This adjustment curve can be used by reading the value along the curve corresponding to the selected interest rate shown. For example, suppose you wanted to know annual canal lining costs for Watershed D-1 which has an annual cost at 3¼ percent interest of $133,000. At an interest rate of 5½ percent, for example, the interception of the index axis and this rate would be 1.45. By multiplying $133,000 by 1.45 a new annual cost of $192,800 can be computed.